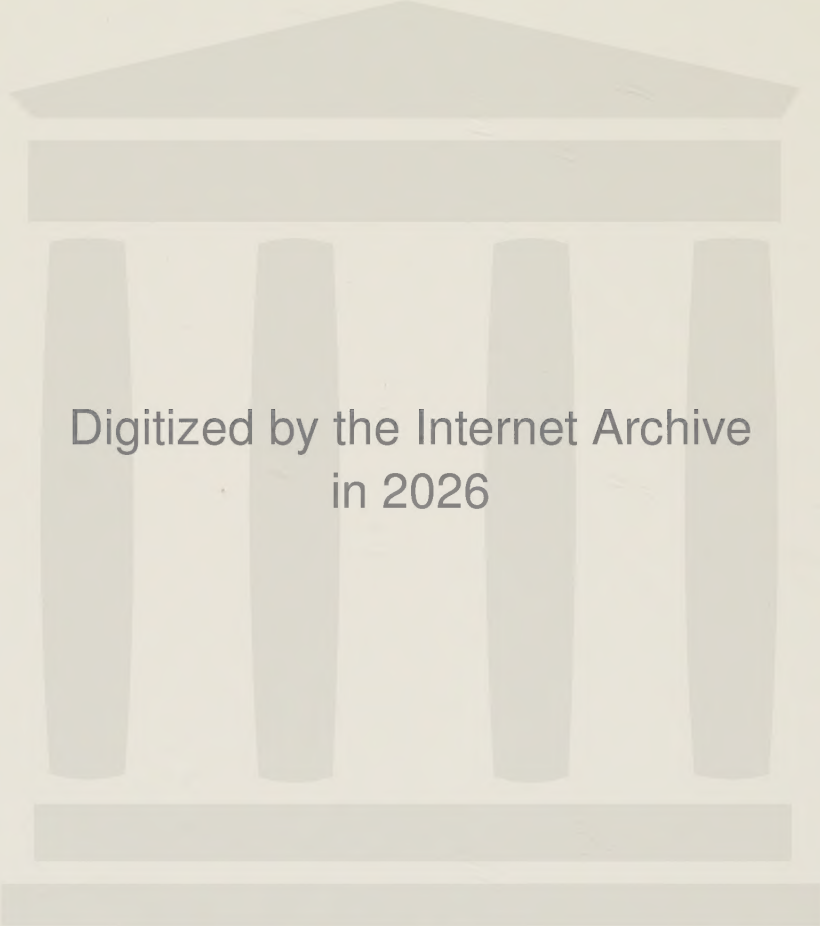


PRE- AND POSTOPERATIVE EVALUATION IN MIDDLE EAR SURGERY

BY
STEN HARRIS

Malmö 1981

Rund 1981



Digitized by the Internet Archive
in 2026

https://archive.org/details/IA41553201_0037

PRE- AND POSTOPERATIVE EVALUATION IN MIDDLE EAR SURGERY

by
Sten Harris

From the Department of Otolaryngology
University of Lund
Malmö General Hospital, Malmö, Sweden

Malmö 1981



*Forewarned, forearmed; to be
prepared is half the victory*

- Cervantes

The present thesis is based on the following papers, which will be referred to in the text by Roman numerals:

- I. Computerized documentation in middle ear surgery.
Methods and clinical experiences.
Acta Otolaryngol (Stockh), Suppl. 374, 1981.
(Harris, S.)
- II. Middle ear mechanics and Eustachian tube function
in tympanoplasty.
Acta Otolaryngol (Stockh), Suppl. 360:141-147, 1979.
(Andréasson, L. & Harris, S.)
- III. Preoperative roentgen examination in ear surgery.
Acta Otolaryngol (Stockh) 91:115-125, 1981.
(Harris, S. & Lörinc, P.)
- IV. Preoperative test of bleeding time in ear surgery.
Acta Otolaryngol (Stockh) 89:474-478, 1980.
(Harris, S. & Nilsson, I.M.)

CONTENTS

	page
Introduction	9
Purposes of the investigation	13
Results	
Paper I Computerized documentation in middle ear surgery.	15
Paper II Middle ear mechanics and Eustachian tube function in tympanoplasty.	19
Paper III Preoperative roentgen examination in ear surgery.	21
Paper IV Preoperative test of bleeding time in ear surgery.	23
General discussion	25
References	31
Acknowledgements	37
Paper I	
Paper II	
Paper III	
Paper IV	

INTRODUCTION

During the last century the indications for ear surgery as well as the surgical methods and materials have changed considerably. Important factors in this development have been the more general use of the operating microscope, which was introduced by Holmgren (1922), the utilization of antibiotics and the advances in anaesthesia. From formerly being mainly concerned with infections and avoidance of life-threatening complications since the beginning of the 1950s ear surgeons more and more have been able to direct their efforts to restoration of hearing after various diseases of the ear (Wullstein, 1953; Zöllner, 1953). Today there are mainly three different purposes of middle ear surgery:

1. to eradicate a disease, such as infection, cholesteatoma and tumours;
2. to prevent discharge by closure of the middle ear and mastoid; and
3. to restore hearing.

The methods used to achieve these goals, however, differ both fundamentally and in detail. To control infection Schwarze & Eysell already 1873 introduced the mastoidectomy. Since this procedure was not always sufficient to drain the ear the radical mastoidectomy operation with destruction of the bony canal was developed (Stacke, 1889; Zaufal, 1890). As hearing often became worse, this procedure was soon modified to a less radical operation, the modified radical mastoidectomy (Bondy, 1909) in which as much as possible of the eardrum and the ossicles was left intact. The open cavity, however, still created problems and several different surgical approaches have been tried, such as skin transplants, skin flaps and obliterative procedures with the use of bone or muscle tissues alone or combined. One of the methods most often used today is that proposed by Palva (1962), especially regarding cholesteatoma (Palmgren, 1977). Another, principally different way to operate for cholesteatoma is the combined approach tympanoplasty (CAT) with preservation of the bony ear canal (Jansen, 1963).

The closure of tympanic membrane perforations in chronic ear disease was not successful until the use of muscle fascia

(Örtegren, 1958, 1964). The fascia, however, can be placed either laterally to the perforation with the overlay technique (Heerman, 1961) or medially with the underlay technique (Storrs, 1961).

For the restoration of hearing in chronic ear disease the tympanoplastic principles introduced by Zöllner (1953, 1955) and Wullstein (1953, 1956) started a new era in reconstructive ear surgery. Especially in reconstruction of the ossicular chain many different methods have been tried. Foreign materials, such as teflon struts (Austin, 1965) and steel wires (Sheehy, 1965; Palva et al., 1971) were tried early. These prothesis were soon dismissed, mainly because of extrusion. Lately new foreign materials, such as proplast, plastipore and ceramics were introduced (Shea, 1976; Hicks et al., 1978; Jahnke & Plester, 1980). However, the material most often used is homograft ossicles (Glasscock & House, 1968), but peroperatively shaped ossicles of cartilage (Shea & Glasscock, 1967) and cortical bone (Ekvall, 1973) are also in common use. The choice of ossicular transplants and the results depend also largely on the absence or presence of stapes superstructures (Austin, 1971).

A special type of surgery for improving hearing are operations for otosclerosis. The first major improvement was the introduction of the one-stage fenestration technique by Lempert (1938). As early as 1890 Miot had reported a material of 200 patients with hearing improvement after stapes mobilization, but the method was abandoned because of the complications and it was not until 1953, when Rosen re-discovered the stapes mobilization that attention was again directed to the oval window. Since stapedectomy was re-introduced in modern time by Shea (1958) the main technical advances have been made possible by the availability of various types of prothesis materials (Schuknecht & Oleksiuk, 1960; House, 1969; Robinson, 1974). Lately the discussion has been focused on small holes versus total removal of the footplate of the stapes (Smyth & Hassard, 1978) and the use of the argon laser in otosclerosis surgery (Perkins, 1980).

With the widening of the range of indications many more patients have become candidates for ear surgery. The incidence of chronic ear disease in Sweden has been calculated to be around 2 % (Tjellström, 1977) and the incidence of clinical otosclerosis has been estimated to be 0.5-1 % (Shambaugh Jr., 1949). Even if

not all of these patients are operated upon, reconstructive ear surgery now constitutes a major part of the surgical activity in many ENT-clinics.

The constant development of new methods has placed many clinicians in a dilemma. As pointed out by Palmgren (1977) and Rahnasto (1979) it is often hard to evaluate the benefits and drawbacks of new methods because of the wide variation of the results. This variation may depend on several factors: the selection of patients operated upon differ in age, the extension of the disease, concomitant infection, besides the duration of follow-up is usually too short (Portmann & Rawat, 1973); a lack of uniformity in the presentation of pre- and postoperative hearing also adds to this picture (Harder et al., 1980). Furthermore, most studies are retrospective, which often means an incomplete evaluation of the surgical outcome.

Besides the variety of surgical methods and procedures there is also a variety of recommended preoperative examinations.

It is generally agreed that all patients with diseases of the ear admitted for surgery must undergo certain preoperative examinations (Guilford, 1963), but agreement has by no means been so wide on the choice and necessity of certain examinations, such as the function of the Eustachian tube and roentgenography.

Thus, though Holmquist (1968) and Andréasson (1973) found tubal function to be good in only 70-80 % of patients with chronic otitis media, many surgeons have operated on such patients without preoperative examination of tubal function and achieved good results in 90 % (Ekvall, 1970; Smyth, 1976a).

Roentgen examination techniques of the ear has developed along with ear surgery. It was formerly used mainly in examinations for acute suppurative mastoiditis (Runström, 1933). With the introduction of tomography with the Polytome technique (Sans & Porcher, 1950) more details could be visualized (Frey, 1956; Mündnich & Frey, 1959; du Boulay & Bostick, 1969; Valvassori & Buckingham, 1975). The absolute need for such preoperative investigations has, however, been questioned (Smyth et al., 1971).

With the development of microsurgical techniques the surgeons were faced with new problems. Even slightly enhanced bleeding can affect the result of an operation (Toremalm & Nilsson, 1970). The usual procedure for controlling the bleeding is careful haemostasis, various forms of low pressure anaesthesia and

locally administered adrenalin. Since some patients still offer bleeding problems a screening procedure seems necessary in order to detect disorders of haemostatic mechanisms preoperatively for prevention of undue bleeding at operation.

As pointed out above, the problems encountered in the analysis of the different measures taken in middle ear surgery have created a need for a standardized way for documentation of all different pre-, per- and postoperative data to make it possible to follow the patients prospectively. The solution to this problem obviously seems to be some kind of computerized documentation, which has already been proposed by Shea (1958) for otosclerosis surgery and by Schmitt & Naumann (1960) for analysis of the results of tympanoplasty.

In order to get a basis for an effective control of our own activity regarding preoperative examinations, results of different surgical procedures as well as a prospective postoperative follow-up the present study was initiated in 1976 with the aims described below.

PURPOSES OF THE PRESENT STUDY

- I. To design and test a computerized system for documentation in ear surgery in order to get continuous information on healing and the effect of treatment on hearing and also to get a "high-risk" list for different surgical procedures. The system should also serve as a detailed data basis for long-term follow-up.
- II. To evaluate the need for certain preoperative procedures where the specific aims were:
 - a) to study any relation between preoperative tests of Eustachian tubal function and determinations of the volume of the airfilled middle ear spaces and the healing results after surgery for chronic otitis media.
 - b) to test the reliability of a simultaneous multisection tomographic technique and to define the indications for preoperative roentgen examination.
 - c) to find a simple method for detecting patients with prolonged bleeding time preoperatively and to find a specific profylactic treatment peroperatively.

1. COMPUTERIZED DOCUMENTATION IN MIDDLE EAR SURGERY

Owing to the wide variety of data that have to be taken into account, statistical analysis in ear surgery is both difficult and time-consuming. Since 1976 we have therefore been using computerized analysis in ear surgery. The data system was designed with the following aims:

1. Data forms should be easy to fill in by all surgeons.
2. The system should allow for relevant modifications of data forms and procedures.
3. The system should serve as a "high-risk" register for certain surgical procedures.
4. Continuous flow of information should be available on hearing and healing in the main groups of operations.
5. The system should serve as a reference for more detailed correlation and long-term follow-up studies.

In this paper the methods are presented as well as our clinical experience with special reference to removal of disease in operations for cholesteatoma, healing in myringoplasty/tympanoplasty and hearing after stapedectomy/ossiculoplasty.

PERFORMANCE

Specially designed data forms were filled in at the time of operation and during follow-up, 2 months $\pm$ 14 days, 6 months $\pm$ 1 month and annually $\pm$ 2 months for up to 5 years after operation. The collected data were handled according to the handling programme schematically presented in Fig. 1. The final results were obtained by running the material through two main data programmes. One is the *Follow-up programme* which is run bimonthly and gives up-to-date information on hearing and healing after different types of operations. The other which is named *Annual Production Control* is run once a year and is based on the results of every specific calendar year. This programme was designed for long-term follow-up and gives a more detailed list of various relations. During the period January 1976 - December 1979 data on 952 miscellaneous ear operations on 770 patient were collected.

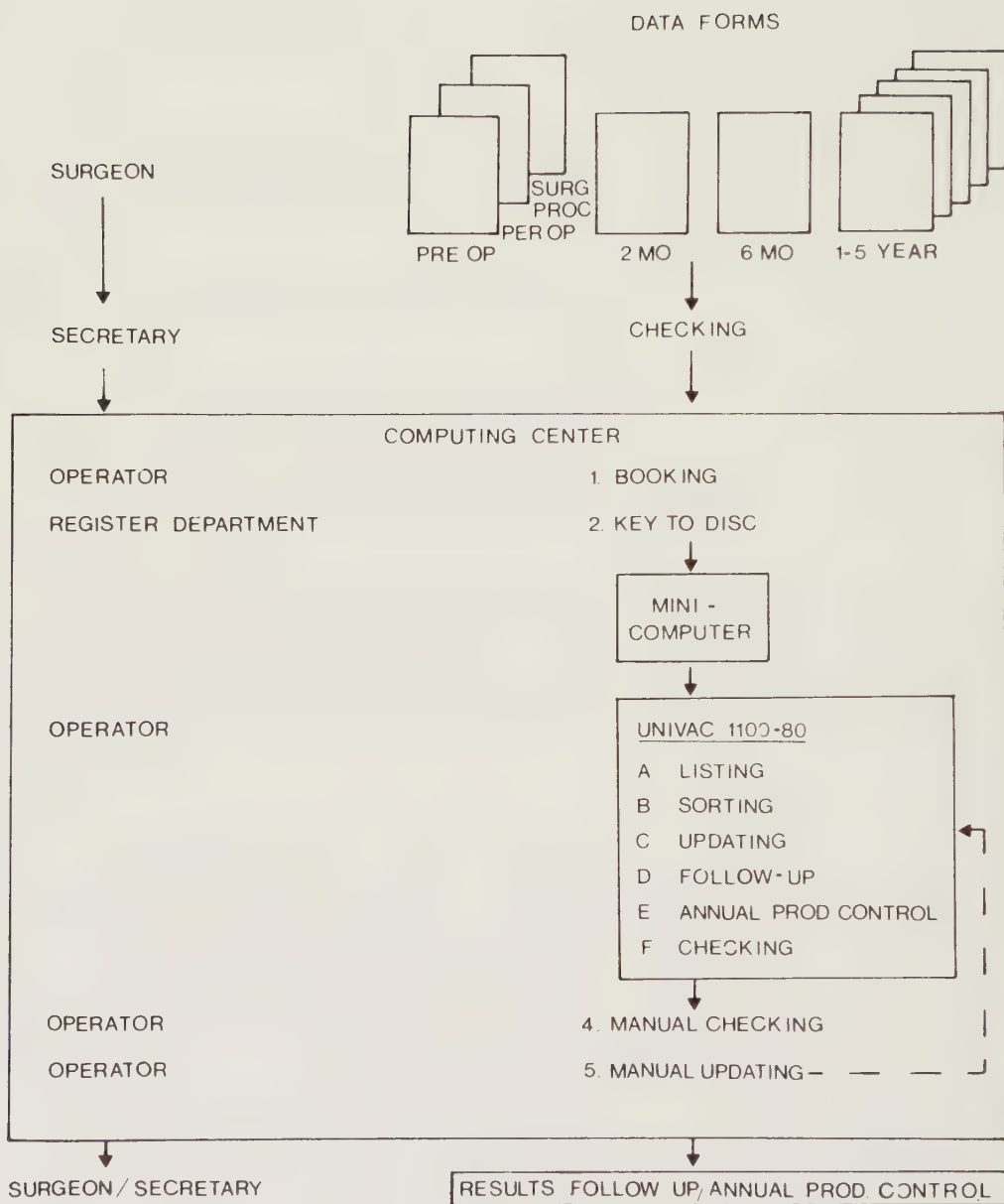


Fig. 1. Schematic illustration of the different steps in handling of data.

The majority of the cases included reconstructive surgery.

RESULTS

Follow-up programme

With the aid of this programme the patients after-examined within the previous 12 months were evaluated every second month. Changes in the clinic's standard could soon be detected with the results presented in this way. The presentation gave information on the risks and prospects of success of any operation offered to our patients. Patients missing an expected control were detected and presented on separate sheets, which hereby could be used as a "high-risk" register.

Annual Production Control

The results of this programme gave a more extensive amount of data which could be compared from year to year or summarized. In order to find out whether the figures presented by the programme were valid also for the patients who did not come to an appointed control we analysed by manual checking the results in this group of patients regarding the findings at the 6-month-control. This check showed that the computerized results were representative of all operations.

In the analysis of the clinical results we found that during the actual period 161 patients had undergone a primary operation for cholesteatoma. In 80 cases a second-look operation was performed and revealed residual disease in 28.8 %. Of the 11 patients subjected to a third look, however, residual cholesteatoma was found in only one.

All grafting of the tympanic membrane was done with temporal fascia and in 109 (89 %) out of 122 patients operated upon during 1978 and 1979 the eardrums had healed by the 6-month-control. A higher take-rate was noted in peroperatively dry ears than in wet ears. A higher frequency of postoperative wound infections was also seen in cases with peroperative discharge.

Stapedectomies were performed with a uniform technique during the period, viz. steel/platinum wire placed on a temporal muscle fascia graft. During the period 1976 - 1979, 84.9 % of the 73

patients had an air-bone gap closure within 0-20 dB. In the ossiculoplasty groups the hearing gain 6 months after reconstruction with various collumellisation techniques was studied. Of the patients with a functionally intact stapes a "successful" air-bone gap closure was achieved in 76 % with a malleo-stapedial assembly (MSA) and in 69 % with a short bone L (slipper interposition). Of the patients where the superstructures of the stapes were missing, an air-bone gap closure within 20 dB was found in 70 % of those with the malleo-footplate assembly (MFPA), in 48 % with the long bone L (LBL) columella and only in 36 % with the long cartilage L (LCL) columella.

CONCLUSIONS

It has been possible to construct a data system which fulfils the aims initially set up. The system was easily adapted to clinical routines and proved to be useful in documentation of clinical results from different points of view.

II. MIDDLE EAR MECHANICS AND EUSTACHIAN TUBE FUNCTION IN TYMPANOPLASTY

Opinions still differ as to whether the results of middle ear surgery vary with the preoperative function of the Eustachian tube. It was therefore thought worth while to study tubal function before and after operation for chronic otitis media.

PERFORMANCE

In 100 patients with a central perforation of the eardrum following chronic otitis media the preoperative status was evaluated with the equipment described by Andréasson and Ivarsson (1976). The following tests were performed:

1. Politzer's test
2. Toynbee's test
3. Aspiration - deflation test at ± 10 cm H₂O and maximum 10 deglutitions
4. Valsalva's test
5. Determination of the volume of the airfilled ear spaces

Between one and three years after surgery (myringoplasty or myringoplasty + ossiculoplasty) the patients were re-examined with the aid of the pressure chamber and microflow meter system first described by Elnér et al. (1971). This time the examination comprised the following tests and measurements:

1. Initial middle ear pressure measurement
2. Valsalva's test
3. Toynbee's test
4. Aspiration - deflation test at ± 10 cm H₂O and maximum 10 deglutitions
5. In certain cases, "sniff test"

Before and after operation also conventional pure tone audiograms were obtained and mean air- and bone-threshold levels were calculated for the speech frequencies.

RESULTS

Preoperatively Politzer's test was positive in all the cases, Valsalva's manoeuvre was positive in 83 % but Toynbee's test in only 37 %. The aspiration test was positive in 72 %. Healing showed no correlation with the preoperative aspiration capacity. The volume of the airfilled ear spaces was measured in 86 ears in the preoperative investigation. Of these, 75 healed with a preoperative mean volume of 3.23 ml but the remaining 10 with a mean volume of 2.48 did not heal. However, no statistical significant difference between the volumes in the two groups was found ($p > 0.05$).

Of the 100 ears, 50 with healed eardrums and 9 with persisting perforations were re-tested. Postoperatively there was a marked improvement of aspiration capacity in the healed group. The ability to perform Valsalva's manoeuvre was unchanged.

CONCLUSIONS

Neither the applied Eustachian tube function tests, i.e. Politzer's test, Toynbee's test, Valsalva's manoeuvre and the aspiration - deflation test nor the determination of the volume of the airfilled ear spaces proved of any value for predicting the outcome in tympanoplastic surgery.

The improvement of aspiration capacity in healed ears also indicated that impairment of Eustachian tube function is probably secondary to causal factors of chronic otitis media.

III. PREOPERATIVE ROENTGEN EXAMINATION IN EAR SURGERY

The development of modern ear surgery has been accompanied by praiseworthy advances in radiography of the temporal bone. Thin-section tomography with the Polytome apparatus has been shown to have a high degree of accuracy. The high purchase costs of the equipment and the time-consuming investigations have, however, restricted the use of the method to a few centres. Since the value of X-ray investigation before ear surgery has been questioned (Smyth et al., 1971; Austin, 1972), many surgeons also lack clear-cut guidelines for requesting preoperative roentgenography.

The purposes of this investigation were:

1. to test the reliability of examination with a simultaneous multisection tomographic technique, and
2. to define the indications for preoperative roentgenography in ear surgery of today.

PERFORMANCE

The material consisted of 680 patients operated upon because of various ear diseases. Preoperatively all the patients were examined on all together 705 occasions with a simultaneous thin-section tomography method first described by McGann (1962) as a plesiosectional tomography technique. A multiscreen cassette with four pairs of matched intensifying screens was used. Since the distance between the consecutive films was 1 mm, the most important parts of the temporal bone could be demonstrated by four exposures in the anteroposterior view. In 27 % also the lateral projection was used. Also six conventional roentgenograms were obtained at all the examinations.

The roentgenographic findings were successively compared with the operative findings, and in cases with discrepancies the films were re-examined to find a plausible explanation for the inconsistencies.

RESULTS

In 587 (83.3 %) out of 705 examinations surgery confirmed the

tomographic findings. The information obtained on tumours, congenital abnormalities, fractures, foreign bodies, infectious complications and most cholesteatomas was both sufficient and reliable.

In 118 (16.7 %) examinations the findings were discordant. The causes of the discrepancies fell into four groups:

- I Misinterpretation - 34 (4.8 %)
- II Technical faults - 12 (1.7 %)
- III Bone lesions too small to be detected by the used
 tomographic method - 46 (6.7 %)
- IV Uncertain causes - 25 (3.5 %)

CONCLUSIONS

Despite the known limitations of the method the simultaneous multisectional tomography technique is valuable in preoperative roentgen examination of the ear. The method is technically easier and not so time-consuming as Polytome single-section tomography.

The analysis of the roentgenologic and surgical findings warrant the following indications for preoperative roentgenography in ear surgery:

Obligatory

- Tumours
- Congenital abnormalities
- Fractures
- Foreign bodies
- Infectious complications

Facultative

- Chronic otitis media with cholesteatoma
- Radical cavities subjected to revision/reconstruction

Questionable

- Chronic otitis media without complications
- Ossicular fixation/deficiencies

IV. PREOPERATIVE TEST OF BLEEDING TIME IN EAR SURGERY

Control of the bleeding is indispensable for successful micro-surgery. In spite of all precautions some patients offer bleeding problems. An investigation was therefore undertaken in order to:

1. detect patients with prolonged bleeding time preoperatively
2. diagnose existing disorders; and
3. find the specific peroperative treatment.

PERFORMANCE

The material consisted of 300 patients with various diseases of the middle ear and air cell system operated upon with mainly tympanoplastic procedures. Preoperatively the bleeding time was determined ad modum Ivy with the modification described by Borchgrevink & Waaler (1958) and Nilsson et al. (1963). In patients with prolonged bleeding time, i.e. > 12 minutes the investigation was extended to include platelet, coagulation and fibrinolytic examinations.

RESULTS AND TREATMENT

In 25 (8.3 %) patients the bleeding time proved prolonged. In 10 the cause was ingestion of acetylsalicylic acid preparations. In 3 others with no history of such ingestion the bleeding time on repeated assay was normal. In 4 cases the further investigation revealed mild thrombasthenia and in one the fibrinolytic activity was increased. No definite diagnosis could be established in 7 cases.

Sixteen of the patients received transaminomethyl cyclohexane carbonic acid (AMCA, Cyklokapron[®]) in a recommended dose of 0.01 g/kg body weight intravenously immediately before the operation. This dose was repeated once or twice on the day of operation. Fresh whole blood was available for all the patients with thrombasthenia and was given on two occasions.

CONCLUSIONS

The incidence of mild thrombasthenia might be as common as that found in our study (1.3 %). Ingestion of acetylsalicylic preparations was the cause of prolonged bleeding in a large proportion of the cases with a prolonged bleeding time. All drugs containing acetylsalicylic acid should therefore be avoided during the last 2 weeks before planned microsurgery of the ear.

At all operations bleeding was satisfactorily controlled with the aid of AMCA and fresh whole blood. This study thus shows the value of determining the bleeding time as a preoperative routine.

GENERAL DISCUSSION

The problems in evaluating reports on middle ear surgery have become more and more apparent during the years since Zöllner (1953, 1955) and Wullstein (1953, 1956) started the modern period of reconstructive surgery. Already in 1965 The Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology (AAOO) presented recommendations for reporting results of surgery for chronic ear infections. These recommendations have also been largely followed by many surgeons (Austin, 1971; Smyth, 1976b; Ginsberg et al., 1978). Further standardization is, however, desirable, especially regarding the presentation of the results of pre- and postoperative hearing tests (Harder et al., 1980; Marquet, 1980).

Another problem in the analysis of the results of ear surgery is the lack of long-term results, which are requested by many authors (Spector, 1973; Donald & Baker, 1979). This is due in part to the vast amount of data that has to be dealt with (Wullstein et al., 1959). The problem could apparently be solved by computerized documentation. As pointed out by White & Uhler (1978) and Ginsberg et al. (1978) a computer-based system should be prospective. In the present study such a method for collecting and handling pre-, per- and postoperative data in a standardized way is presented (paper I). The system presented can be readily adapted to suit the requirements of any ENT-clinic. The data forms permit rapid filling-in without the surgeon having to consult a special manual for code numbers. The data are processed at a computing center outside the clinic (LUND University Computing Center) which means that at least all Swedish ENT-clinics can be immediately connected to the system. In a project of this type also the ready availability of a programmer is essential in order to adapt the programmes to changes in techniques, materials and standards of evaluation. Furthermore, several clinics have the possibility to accumulate information in a data pool and thus get relevant statistical data much sooner than otherwise.

Two main programmes have been developed. One (the Follow-up programme) was designed to provide a ready updated survey of a few parameters, i.e. hearing and healing. The idea was that it should be possible to detect unfavourable results or changes in the results without undue delay. In this way a toxic effect like

that of chlorhexidin (Bicknell, 1971) could hopefully be detected early. The effects of changes in methods and surgical training programmes soon also become evident. The follow-up programme also functions as a "high-risk" register, since patients that have not come to an appointed control are presented on separate lists. This is of special interest in cholesteatoma surgery where the dominant technique in our clinic is CAT with a planned second look.

The second main programme (Annual production control) was intended to give more detailed information about various relations between the documented data and also to serve as a basis for long-term results. The capacity of this programme has been studied in some clinical situations.

In cholesteatoma surgery the frequency of residual cholesteatoma could be easily demonstrated. The figures showed that the overall frequency (28.8 %), the higher incidence (50 %) in children and the predominance for residual disease in the middle ear agreed with what has been reported in other re-operated materials (Smyth, 1976b, Sheehy et al., 1977). The extent of the disease at the second look, however, was as a rule much more restricted and the operative conditions were much more favourable than at the primary operation. This probably explains why we have so far only found one cholesteatoma in the third-look operation. In our opinion, this finding should encourage a continued use of closed technique surgery with planned staging.

The figures for healing after myringoplasty/tympanoplasty procedures showed that in our hands the take-rate in eardrum grafting was lower in wet ears. This could be due to the infection itself or to technical problems often encountered in draining ears with more profuse bleeding. The consequence is, however, that more consideration must be given to efforts aiming at getting the ear as dry as possible in the preoperative treatment.

In otosclerosis surgery our results seem to be in agreement with those on record with an air-bone gap closure within 20 dB in 85 % of the stapedectomies (Hammond, 1976; Strauss & Strahl, 1976; Palva et al., 1977). It also became obvious that post-operative bone conduction should be used when calculating the postoperative ABG, since such a large proportion of the patients experienced improvement of bone conduction (13.7 % at the 6-month-control). This is contrary to the advice given by the

AAOO (1965).

In the ossiculoplastic evaluation, however, the results were less rewarding, and especially in cases where all the ossicles are missing other techniques must be looked for.

An interesting finding in paper II was that the tubal function tests indicated an improved function in healed ears. In their investigation Siedentop et al. (1968) found a tendency to improvement, which they attributed to the surgical procedures, i.e. removal of granulations and polyps at the tubal orifice of the middle ear. In our material, however, no such lesions were seen in the 13 ears transferred from the negative to the positive group. The most probable explanation for this is some change in the functional status of the middle ear mucosa. Since the volume of the mucosal lining is highly dependent on the blood filling, a change in volume could be explained by an alteration in the environmental conditions in the closed middle ear. A reversal of the histopathological changes described by Zechner (1979) may also contribute to the improved function. Another explanation may be that in ears with perforated drums there is no pressure difference across the Eustachian tube, but when the ear is closed the intratympanic environment is more physiologic with repeated periods of underpressure, which might perhaps trigger some mechanism inducing the tube to start functioning. It cannot be excluded that the above phenomena can explain why Koch (1980) could not demonstrate any improvement in Eustachian tube function in his long-term study after tympanoplasty, at which he inserted a grommet tube and thereby left the middle ear permanently open.

In our opinion the postoperative improvement in tubal function thus indicates that impairment of tubal function is secondary to other factors responsible for the development of chronic otitis media.

According to Ekvall & Magnusson (1977), the patients' "sniffing habits" might be an important pathophysiological factor in middle ear disease. In our postoperative study only 6 (19 %) out of 32 could propagate a negative rhinopharynx pressure to the middle ears. It might be possible that in chronic otitis media this mechanism is a contributory cause in some cases of the disease. In adhesive middle ears and in the development of cholesteatomas the "sniffing habit" probably deserves more attention and should always be considered in the preoperative investigation of the

patient.

In our study several methods were used in the evaluation of Eustachian tube function. Politzer's and Valsalva's tests can be regarded as tests of patency (Andréasson & Ivarsson, 1976). A positive Politzer's test means only that there is no organic stenosis of the Eustachian tube. The ability to perform a positive Valsalva's manoeuvre is probably favourable for the postoperative aeration of the middle ear (Tos, 1974). The aspiration - deflation test better reflects the normal physiological conditions and is also most widely used (Miller, 1965; Flisberg, 1966; Holmquist, 1968; Siedentop et al., 1968; Palva & Kärjä, 1970; Bluestone et al., 1979; Cohn et al., 1979). Some objections to the test can, however, be raised. One is that the test period is only 2-3 minutes and thus does not take into account possible fluctuation during a longer period of time. Another is that some individuals equilibrate the underpressure created in their middle ears by ways other than swallowing, i.e. by yawning, by moving their jaws or even by auto-inflation (Bylander, 1980).

The roentgenological study (paper III) included the use of a less common technique, namely simultaneous multisection tomography (McGann, 1962). The advantages of this technique over single-section Polytome tomography are that the apparatus is cheaper and the examination is less time-consuming. The time required is only about one fourth of that for single-section Polytome tomography. This, in turn, means that it is easier to keep the patients, and especially children, immobile, which is a prerequisite for a good roentgenogram. The anteroposterior projection depicts both sides in a single film, which facilitates orientation and comparison of the two ears. This projection is also easy to set and reproduce. All these factors should make it easier for smaller roentgenological departments to include tomography of the ear as a routine investigation.

The resolving power of single-section Polytome tomography with hypocycloid or spiral blurring, on the other hand, is better, which means that tiny structures of the middle ear, such as part of the long process of the incus and the stapedial crura cannot be expected to be visualized by the simultaneous multisection tomography technique. Some authors believe that simultaneous multisection tomography exposes the patient to less radiation than single-section tomography (Gajewski & Liese, 1955; Balevich

& Kitaev, 1972).

The introduction of computerized tomography (CT) has improved the diagnostic capacity of roentgenology during the last few years. As for the application of CT in the examination of the temporal bone, it has been tried in the diagnosis of tumours, such as acoustic neuromas and glomus jugulare tumours (Davis et al., 1977; Möller et al., 1978; Rettinger et al., 1980). In the detection of smaller changes in bony structures in the middle ear and cellular system conventional tomography is still superior (Phelps & Lloyd, 1980; Schaffer & Haughton, 1980). One of the reasons is that the sections of CT are still not thin enough. We can, however, expect further improvement in this field (Hanafée et al., 1980).

Judging from our experience, the indication for preoperative roentgenology is obligatory when the ear disease is caused by tumour, congenital abnormality, fracture, foreign body or an infectious complication. If only these indications had been applied, in our material only 30 (4.3 %) cases would have been investigated during a 10-year period. We therefore recommend also preoperative examination when there is a facultative indication, i.e. cholesteatoma surgery and revision/reconstruction of radical mastoidectomy cavities. This would have increased the number by another 37 % of the total material. This also means that the roentgenologist would get the possibility of acquiring sufficient experience and that the surgeon would not be deprived of sometimes valuable preoperative knowledge. Irrespective of the methods used, close cooperation between roentgenologist and surgeon is indispensable if adequate standards of roentgenology of the ear are to be maintained.

For detecting conditions with a prolonged bleeding time the Ivy test is probably the most sensitive screening method. In our study we cannot exclude a false positive test in 3 cases, since the re-test gave a normal value. In spite of its simplicity, the Ivy test requires experienced laboratory personnel. Recently, however, General Diagnostics has introduced a device (Simplat IITM) which gives standardized cuts. A comparison between the results found with Simplat IITM and the method used in our study showed good agreement (Nilsson et al., 1979). This means that Ivy's test can be performed in a satisfactory way in all departments of surgery.

The high incidence of prolonged bleeding time in our study was unexpected. In 4 patients (1.3 %) we could demonstrate mild thrombasthenia. These patients had a normal number of platelets, but prolonged bleeding time and decreased adhesiveness (Cronberg, 1968). In 4 other patients thrombasthenia could not be excluded. Some observations (Blombäck, 1972) indicate that it might be a common condition. Several patients had a prolonged bleeding time due to ingestion of acetylsalicylic acid preparations. This was sometimes also found in patients who had been instructed not to take this type of medicine. The explanation here is twofold. Firstly, the effect of acetylsalicylic acid lasts up to two weeks, even for small amounts of the drug (Cronberg, 1968). Secondly, this substance is a component of many drugs of which the patients do not know the constituents. Our recommendation is therefore to use specific drugs containing paracetamol if the patients need analgetics during the last fortnight before operation. During the operation the patients with a prolonged bleeding time received AMCA. Since transient nausea was noted as an adverse effect of this drug and since vomiting may impair the result of ear surgery the prophylactic use of AMCA should be restricted to patients with a verified prolonged bleeding time.

Conclusively, for pre- and postoperative evaluation in middle ear surgery the study has shown:

the advantages of the presented computerized documentation system especially for obtaining a "high-risk" register in cholesteatoma surgery and a continuous flow of information regarding healing and hearing in reconstructive ear surgery;

that present methods for Eustachian tube function cannot be used to predict the outcome of tympanoplastic surgery;

the reliability and value of examination with a simultaneous multisection tomographic technique to give the indications for preoperative roentgenography; and

the value of preoperative determination of the bleeding time.

REFERENCES

- Andréasson, L. 1973. Kronisk slemhinneotit. Preoperativ bedömning. Thesis, Malmö, Sweden. (in Swedish).
- Andréasson, L. & Ivarsson, A. 1976. On tubal function in presence of central perforation of the drum in chronic otitis media. *Acta Otolaryngol* (Stockh) 82, 1.
- Austin, D.F. 1965. Present status of vein graft tympanoplasty. *Arch Otolaryngol* 81, 20.
- 1971. Ossicular reconstruction. *Arch Otolaryngol* 94, 525.
- 1972. Transcanal tympanoplasty. *Otolaryngol Clin North Am* 5, 127.
- Balevich, O. & Kitaev, V. 1972. Thinlayer simultaneous tomography of the pyramids of the temporal bones. *Vestn Otorhinolaringol* 34, 64.
- Bicknell, P. 1971. Sensorineural deafness following myringoplasty operations. *J Laryngol Otol* 85, 957.
- Blombäck, M. 1972. Training in blood coagulation pays? *Läkartidningen* 69, 2515.
- Bluestone, C., Cantekin, E. & Douglas, G. 1979. Eustachian tube function related to the results of tympanoplasty in children. *Laryngoscope* 89, 450.
- Bondy, G. 1909. Radikaloperation mit Erhaltung von Trommelfell und Gehörknöchelchen bei Fistelsymptom. *Monatsschr Ohrenheilkd Laryngorhinol* 7, 185.
- Borchgrevink, C.F. & Waaler, B. 1958. The secondary bleeding time. A new method for differentiation of haemorrhagic diseases. *Acta Med Scand* 162, 361.
- du Boulay, G. & Bostick, T. 1969. Linear tomography in congenital abnormalities of the ear. *Br J Radiol* 42, 161.
- Bylander, A. 1980. Comparison of Eustachian tube function in children and adults with normal ears. *Ann Otol Rhinol Laryngol*, Suppl. 68, 89.
- Cohn, A., Anthony, L., Schwaber, M. & Jerger, J. 1979. Eustachian tube function and tympanoplasty. *Ann Otol Rhinol Laryngol* 88, 339.
- Cronberg, S. 1968. Investigations in haemorrhagic disorders with prolonged bleeding time but normal numbers of platelets. *Acta Med Scand*, Suppl. 486.
- Davis, K., Parker, S., New, P., Roberson, G., Taveras, J., Ojemann, R. & Weiss, A. 1977. Computed tomography of acoustic neuroma. *Radiology* 124, 81.

- Donald, P. & Baker, S. 1979. Hearing results following atticotomy. *Laryngoscope* 89, 195.
- Ekvall, L. 1970. Eustachian tube function in tympanoplasty. *Acta Otolaryngol* (Stockh), Suppl. 263, 33.
- 1973. Total middle ear reconstruction. *Acta Otolaryngol* (Stockh) 75, 279.
- Ekvall, L. & Magnusson, B. 1977. Reverse aspiratory middle ear disease. A neglected pathogenic principle. Lecture at XIth World Congress on Otolaryngology, Buenos Aires.
- Elner, Å., Ingelstedt, S. & Ivarsson, A. 1971. A method for studies of the middle ear mechanics. *Acta Otolaryngol* (Stockh) 72, 191.
- Flisberg, K. 1966. Ventilatory studies on the Eustachian tube. *Acta Otolaryngol* (Stockh), Suppl. 219.
- Frey, K.W. 1956. Schichtaufnahmen des Felsenbeines mit polyzyklischer Verwischung. *ROEFO* 85, 433.
- Gajewski, H. & Liese, E. 1955. Das Simultanschichtverfahren. Aufnahmtechnische Grundlagen und medizinische Anwendung. *ROEFO* 83, 567.
- Ginsberg, I., Hoffman, S., Stinziano, G. & White, T. 1978. Stapedectomy - in depth analysis of 2405 cases. *Laryngoscope* 88, 1999.
- Glasscock, M.E., III & House, W.F. 1968. Homograft reconstruction of the middle ear. A preliminary report. *Laryngoscope* 78, 1219.
- Guilford, F.R. 1963. Preoperative evaluation in chronic ear disease. Selection of patients for tympanoplasty. *Arch Otolaryngol* 78, 271.
- Hammond, V. 1976. The indications for stapedectomy. *J Laryngol Otol* 90, 23.
- Hanafee, W.N., Mancuso, A., Winter, J., Jenkins, H. & Bergström, L.V. 1980. Edge enhancement computed tomography scanning in inflammatory lesions of the middle ear. *Radiology* 136, 771.
- Harder, H., Jerlvall, L., Kylén, P. & Ekvall, L. 1980. Calculation of hearing results after tympanoplasty. *Clin Otolaryngol*. (in press).
- Heermann, J. 1961. Trommelfellplastik mit Faszienewebe vom Musculus temporalis nach Begradigung der vorderen Gehörgangswand. *HNO* 9, 136.
- Hicks, G.W., Wright, J.W. Jr. & Wright, J.W., III. 1978. Use of plastipore for ossicular chain reconstruction: An evaluation. *Laryngoscope* 88, 1024.

- Holmgren, G. 1922. Operations on the temporal bone carried out with the help of the lens and the microscope. *Acta Otolaryngol* (Stockh) 4, 383.
- Holmquist, J. 1968. The role of the Eustachian tube in myringoplasty. *Acta Otolaryngol* (Stockh) 66, 289.
- House, H.P. 1969. Five-year study of wire loop-absorbable gelatin sponge technique. *Arch Otolaryngol* (Chicago) 89, 420.
- Jahnke, K. & Plester, D. 1980. Keramik-implantate in der Mittelohrchirurgie. *HNO* 28, 109.
- Jansen, C. 1963. Cartilage-tympanoplasty. *Laryngoscope* 73, 1288.
- Koch, U. 1980. Beeinflussung der Tubenfunktion bei chronischer Mittelohrentzündung durch die Tympanoplastik and anschliessende Dauerbelüftung. *HNO* 28, 187.
- Lempert, J. 1938. Improvement of hearing in cases of otosclerosis: New one-stage surgical technique. *Arch Otolaryngol* 28, 42.
- Marquet, J. 1980. Audiological evaluation after tympanoplasty. Presented at the XV Congress of Audiology, Cracow. *Audiology*. (in press).
- McGann, M. 1962. Plesiosectional tomography of the temporal bone. A new multiscreen cassette. *Am J Roentgenol* 88, 1183.
- Miller, G.F., Jr. 1965. Eustachian tubal function in normal and diseased ears. *Arch Otolaryngol* 81, 41.
- Miot, C. 1890. *Rev Laryngol Otol Rhinol* 10, 49.
- Möller, A., Hatam, A. & Olivercrona, H. 1978. Diagnosis of acoustic neuroma with computed tomography. *Neuroradiol* 17, 25.
- Mündnich, K. & Frey, K.W. 1959. Das Röntgenschnittbild des Ohres. Thieme, Stuttgart.
- Nilsson, I.M., Magnusson, S. & Borchgrevink, C. 1963. The Duke and Ivy methods for determination of the bleeding time. *Thromb Haemostas* 10, 223.
- Nilsson, L., Tengbom, L. & Nilsson, I.M. 1979. Ett nytt hjälpmedel för standardiserad blödningstidsbestämning. *Opuscula Medica* 24, 65.
- Örtegren, U. 1958. Förhandlingar i Svensk Otolaryngologisk förening. (in Swedish).
- 1964. Myringoplasty: Four years' experience of temporal fascia grafts. *Acta Otolaryngol* (Stockh), Suppl. 193, 1.
- Palmgren, O. 1977. Operationsresultat vid aktiv kronisk mellanöroninflammation. En klinisk studie vid lång observationstid. Thesis, Helsinki, Finland. (in Swedish).

- Palva, A. & Kärjä, J. 1970. Eustachian tube patency in chronic ears. Preoperative evaluation correlated to postoperative results. *Acta Otolaryngol* (Stockh), Suppl. 263, 25.
- Palva, T. 1962. A new approach to radical surgery of the chronic otitis media. *Pract Otorhinolaryngol* (Basel) 24, 372.
- Palva, T., Palva, A. & Kärjä, J. 1971. Results with 2- or 3-legged wire columellisation in chronic ear surgery. *Ann Otol Rhinol Laryngol* 80, 760.
- Palva, T., Kärjä, J. & Palva, A. 1977. Otosclerosis surgery. *Acta Otolaryngol* (Stockh) 83, 328.
- Perkins, R.C. 1980. Laser stapedectomy for otosclerosis. *Laryngoscope* 90, 228.
- Phelps, P.D. & Lloyd, G.A.S. 1980. The radiology of cholesteatoma. *Clin Radiol* 31, 501.
- Portmann, M. & Rawat, Y.A. 1973. A propos des récidives a long terme du cholesteatome. *Rev Laryngol Otol Rhinol* (Bord) 94, 13.
- Rahnasto, J. 1979. Long-term results of myringoplasty and tympanoplasty. Thesis, Helsinki, Finland.
- Rettinger, G., Rogalsky, W. & Panis, R. 1980. Computertomographie bei Erkrankungen des HNO-Bereiches. Indikation und Aussagekraft. *HNO* 28, 119.
- Robinson, M. 1974. Stapes prosthesis: Stainless steel vs. Teflon. *Laryngoscope* 84, 1982.
- Rosen, S. 1953. Mobilization of the stapes to restore hearing in otosclerosis. *NY State J Med* 53, 2650.
- Runström, G. 1933. A roentgenological study of acute and chronic otitis media. *Acta Radiol*, Suppl. XVII.
- Sans & Porcher 1950. Polytome. *J Radiol Electrol Med Nucl* 31, 300.
- Schaffer, K. & Haughton, V. 1980. Thin section computed tomography of the temporal bone. *Laryngoscope* 90, 1099.
- Schuknecht, H.F. & Oleksiuk, S. 1960. The metal prosthesis for stapes ankylosis. *Arch Otolaryngol* (Chicago) 71, 287.
- Schmitt, H. & Naumann, H. 1960. Ein Vorschlag zur Dokumentation und Statistik der Ohroperationen. *Med Dokum* 4, 30.
- Schwartz, H. & Eysell, A. 1873. Über die künstliche Eröffnung des Wartenfornsatzes. *Arch Ohrenheilkd* 7, 157.
- Shambaugh, G.E., Jr. 1949. Fenestration operation for otosclerosis. *Acta Otolaryngol* (Stockh), Suppl. 79.
- Shea, J.J. 1958. Fenestration of the oval window. *Ann Otol Rhinol Laryngol* 67, 932.

- Shea, J.J. 1976. Plastipore total ossicular replacement prosthesis. *Laryngoscope* 86, 239.
- Shea, M.C. & Glasscock, M.E., III. 1967. Tragal cartilage as an ossicular substitute. *Arch Otolaryngol* 86, 308.
- Sheehy, J.L. 1965. Ossicular problems in tympanoplasty. *Arch Otolaryngol* 81, 115.
- Sheehy, J., Brackman, D. & Graham, M. 1977. Cholesteatoma surgery: residual and recurrent disease. *Ann Otol Rhinol Laryngol* 86, 451.
- Siedentop, K.H., Tardy, M.E. & Hamilton, L.R. 1968. Eustachian tube function. *Arch Otolaryngol* 88, 386.
- Smyth, G.D.L. 1976a. Tympanic reconstruction. Fifteen-year report on tympanoplasty. Part II. *J Laryngol Otol* 90, 713.
- 1976b. Postoperative cholesteatoma in combined approach tympanoplasty. *J Laryngol Otol* 90, 597.
- Smyth, G., Kerr, A. & Goodey, R. 1971. Current thoughts on combined approach tympanoplasty. *J Laryngol Otol* 85, 205.
- Smyth, G.D.L. & Hassard, T.H. 1978. Eighteen years experience in stapedectomy - the case for the small fenestra operation. *Ann Otol Rhinol Laryngol* 87, Suppl. 49, 3.
- Spector, G., Pratt, L. & Randall, G. 1973. A clinical study of delayed reconstruction in ossicular fractures. *Laryngoscope* 83, 837.
- Stacke, L. 1889. Betrachtungen über gegenwärtige Stand der Therapie chronischer Mittelohreiterungen. *Berl Klin Wochenschr* 26, 350.
- Storrs, L.A. 1961. Myringoplasty with the use of fascia grafts. *Arch Otolaryngol* 74, 45.
- Strauss, P. & Strahl, M. 1976. Spätergebnisse nach über 15 Jahren Stapedektomie. *Laryngol Rhinol Otol* (Stuttg) 55, 217.
- The Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology 1965. Standard classification for surgery of chronic ear infection. *Arch Otolaryngol* 81, 204.
- Tjellström, A. 1977. Tympanoplasty with preformed autologous ossicles. Thesis, Gothenburg, Sweden.
- Toremalm, N.G. & Nilsson, I.M. 1970. Stapedectomy in a patient with von Willebrand's disease. *Ann Otol Rhinol Laryngol* 79, 331.
- Tos, M. 1974. Tubal function and tympanoplasty. *J Laryngol Otol* 88, 113.
- Valvassori, G. & Buckingham, R. 1975. Tomography and Cross Sections of the Ear. Thieme, Stuttgart.

- White, T. & Uhler, L. 1978. Procedures for preparation of otological and audiological data for computer analysis. *Laryngoscope* 88, 1836.
- Wullstein, H. 1953. Die Tympanoplastik als gehörverbessernde Operation bei Otitis media chronica und ihre Resultate, pp. 104-117. In *Proceeding of the 5th International Congress of Oto-rhino-laryngology*, Amsterdam. Koninklijke Van Gorcum & Co., Assen, The Netherlands, publ. 1955.
- 1956. Theory and practice of tympanoplasty. *Laryngoscope* 66, 1076.
- Wullstein, H.L., Schmitt, H.G. & Naumann, H.W. 1959. Société internationale d'audiologie. IV^e Congrès Padova, Audin-Lyon.
- Zaufal, E. 1890. Die Technik der Trepanation des Proc. mastoid. nach Küsterschen Grundsätzen. *Arch Ohrenheilkd* 30, 291.
- Zechner, G. 1979. Der Zustand der Ohrtrompete und dessen Einfluss auf das Mittelohr. *Acta Otolaryngol* (Stockh) 87, 353.
- Zöllner, F. 1953. Hörverbessernde Eingriff am Schalleitungsapparat, pp. 119-126. In *Proceedings of the 5th International Congress of Oto-rhino-laryngology*, Amsterdam. Koninklijke Van Gorcum & Co., Assen, The Netherlands, publ. 1955.
- Zöllner, F. 1955. The principles of plastic surgery of the sound conducting apparatus. *J Laryngol Otol* 69, 637.

ACKNOWLEDGEMENTS

I wish to express my sincere gratitude

to the late Professor Sven Ingelstedt
for initiating and encouraging the study;

to Professor Nils Gunnar Toremalm and co-workers
of the Department of Otolaryngology for all help;

to my co-authors Professor Inga Marie Nilsson,
Docent Lars Andréasson and Doctor Pal Lörinc
for excellent collaboration and support;

to Miss Bodil Nilsson for excellent type-writing;

to Mr James Brown for revising the English text.

This work was supported by the General Hospital in Malmö,
the Medical Faculty, University of Lund and
grants from the Swedish Medical Research Council
(project No. B80-19X-0087-16C).

ACTA OTO-LARYNGOLOGICA

SUPPLEMENT 374

COMPUTERIZED DOCUMENTATION IN MIDDLE EAR SURGERY

Methods and Clinical Experiences

by

Sten Harris

*From the ENT-Department, University of Lund
General Hospital, Malmö, Sweden*

MALMÖ 1981

COMPUTERIZED DOCUMENTATION IN MIDDLE EAR SURGERY

Methods and Clinical Experiences

Sten Harris

*From the ENT-Department, University of Lund, Malmö General
Hospital, S-214 01 Malmö, Sweden*

Abstract. A computerized system for recording results of ear surgery is presented. Specially designed forms are filled in at the time of operation as well as 2 months, 6 months and annually for 1-5 years after operation. The data are processed in a Univac 1100-80 by specific programmes written in FORTRAN. A Follow-up programme gives up-to-date information on hearing and healing after different types of operations. An Annual Production Control programme gives more detailed information about various correlations, such as results in draining ears, frequency of residual cholesteatoma etc. Four years experience with the system and obtainable data is discussed.

CONTENTS

INTRODUCTION

METHODS

Collection of data

- a) preoperative state
- b) peroperative state
- c) surgical procedures
- d) postoperative state

Handling of data

- a) follow-up programme
- b) annual production control

Audiometry

MATERIAL

RESULTS

Follow-up programme

Annual production programme

- 1) Cholesteatoma surgery
- 2) Healing of the tympanic membrane
- 3) Hearing after stapedectomy
- 4) Hearing after ossiculoplasty

DISCUSSION

APPENDIX

INTRODUCTION

Statistical analysis in ear surgery is both time-consuming and difficult owing to the large quantity and the wide variety of data and variables that have to be taken into account. This is due to the advances made in reconstructive middle ear surgery during the last 30 years which has resulted in the development of many new diagnostic methods and surgical procedures. Another main cause is the ready availability of all audiometric data necessary to give an adequate description of hearing acuity before and after surgery. Wullstein et al. (1959), for instance, in a short-time survey of 300 patients operated upon unilaterally for otosclerosis with the fenestration technique used 67 000 pieces of information. This explains why computers had to be introduced so early. Shea (1958, 1960, 1964) was the first to propose the use of a punch card system in the analysis of the results of surgery for otosclerosis. Schmitt & Naumann (1960) and Wullstein et al. (1961) presented a punch card system for evaluation of the results of tympanoplasty. Further details of punch card systems have been published by Smyth (1976a, 1977). Also more advanced computerized systems and programmes have been recommended (Pfaltz et al., 1975; Strauss et al., 1977; White & Uhler, 1978).

In an effort to get a basis of data for an effective control of preoperative evaluation, improvement in surgical procedures and postoperative follow-up we have introduced a system for computerized analyses in ear surgery in our department (Harris et al., 1977). This data system was designed to meet the following requirements:

1. Data forms should be easy to fill in by all ear surgeons.
2. The system should allow for adaption to relevant modifications of data forms and procedures.
3. The system should serve as a "high-risk" register for certain surgical procedures.
4. Continuous flow of information should be available on hearing and healing results of the main groups of surgical procedures.
5. The system should serve as a base for more detailed correlation and long-term follow-up studies.

After the system had been tested for 4 years the present study was carried out with the following aims:

1. to present the data system used and to evaluate the practical handling;
2. to present our clinical experience of the system with special reference to a) removal of disease (operations for cholesteatoma), b) healing (in myringoplasty/tympanoplasty), and c) hearing (after stapedectomy/ossiculoplasty); and
3. to test the reliability of the method compared to the results obtained by a manual check of data on those patients in whom the postoperative results had for various reasons not been fed into the computer.

METHODS

Collection of data

Specially designed data forms (see Appendix, form 1-4) are filled in at the time of operation and during follow-up. The follow-up checks are done 2 months $\pm$ 14 days, 6 months $\pm$ 1 month and annually $\pm$ 2 months, for up to five years after operation.

Preoperative state. In Sweden all people have an individual ten digit birth-number, which is used as identification number in the data file. Data on hearing are usually collected on the day before operation (Appendix, form 1A).

Peroperative state. Each surgeon is identified by an alphabetical code. Relevant data are collected on the ear canal, the tympanic membrane, the ossicular chain, the mucous membranes, cholesteatomatous disease and any other noteworthy findings (Appendix, form 1B).

Surgical procedures. An attempt is made to adapt the terminology to that currently used (The Committee on Conservation of Hearing, 1965; Smyth, 1976b). The actual operation is finally classified under one or another of nine headings in the form. Myringoplasty is defined as repair of the drum in an ear with an intact ossicular chain. The tympanoplasty groups include also other procedures. "Tympanoplasty B"-operations consist mainly of combined approach

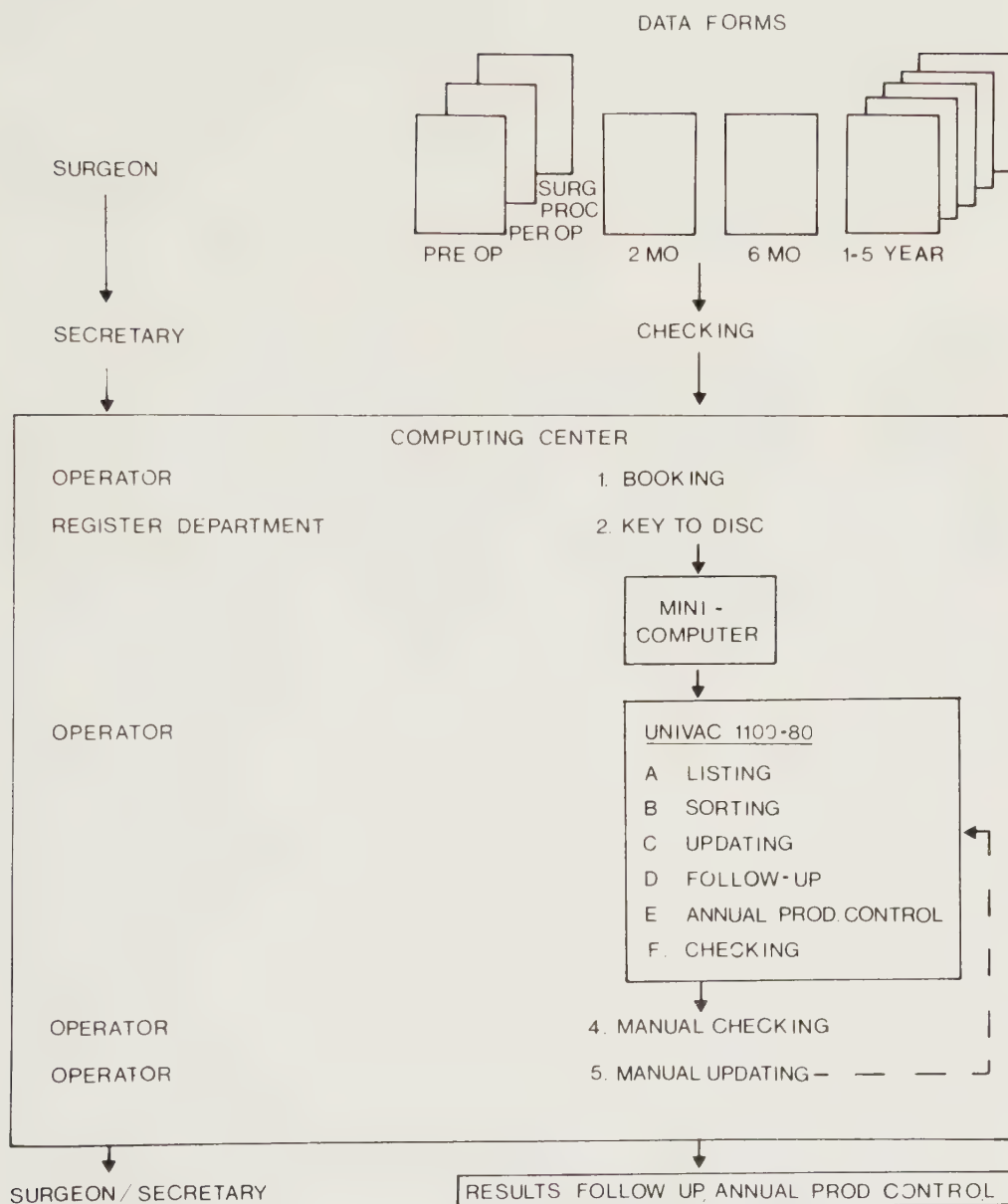


Fig. 1. Schematic illustration of the different steps in handling of data.

tympanoplasty (CAT) operations for cholesteatoma. The term "total reconstruction" is used to designate reconstruction of a radical cavity including a new bony ear canal. In the ossiculoplasty group the only surgical procedure is reconstruction of the chain in an ear with an intact drum. The radical mastoidectomy group comprises also modified radical mastoidectomy (Bondy operation) (Appendix, form 1C).

Postoperative state. Air-bone gap (ABG) is always calculated from the postoperative bone conduction. The bone conduction is always evaluated relative to the preoperative value. Complications refer to the period since the last control (Appendix, forms 2, 3 and 4).

Handling of data

The various steps are illustrated in Fig. 1. The data forms are continually collected by a responsible secretary who checks the identity No., op. No., side of the disease and completeness of the forms. Every second month the forms collected are sent to LUND University Computing Center, where the data are finally processed in a master computer, at present a Univac 1100-80 for which the programmes are written in FORTRAN. The results are presented by two main programmes designed *Follow-up* and *Annual production control*. The data forms, data handling procedures and the data programmes have been continually modified without altering the basic principles or affecting earlier accumulated data.

In the *Follow-up programme* all the patients after-examined on any occasion within the previous 12 months are included in the evaluation. Every second month the results regarding hearing and healing are summarized. Patients missing an appointed control are noted on a separate sheet and appropriate measures are then taken. Cholesteatoma patients missing a follow-up are also noted on a separate list, which thus constitutes a "high-risk" register.

The *Annual production control programme* is processed once a year as well as at any time the actual figures may be required for any particular purpose. This programme is based on the findings in every specific calendar year and is designed for long-term follow-up and gives a more detailed list of various correlations.

Both programmes thus provide data, which can serve as a clinical production control.

Audiometry

Pure-tone hearing for air- and bone conduction are recorded with the aid of a clinical audiometer (Madsen OB 70), together with matched TDH39 earphones, fitted with MX 41/AR cushions for air conduction. A bone vibrator from Radio Ear (B 71) is used for bone conduction (BC). The audiometric zero for air-threshold is calibrated according to ISO (1964). The audiometric zero for bone-thresholds is calibrated according to the Swedish Technical Audiological Society (STAF, 1975). Mean air- and bone-threshold levels are calculated for the frequencies 500, 1000 and 2000 Hz. The air-bone gap (ABG) is defined as the difference between the mean values of air and bone conduction.

For speech audiometry Swedish word lists originally composed by Lidén & Fant (1954) and afterwards modified by Bertil Johansson (1966) are used. The tape-recorded lists are presented from a tape recorder (Fonema) and the above-mentioned outfit for pure-tone audiometry. According to Pfaltz (1975), a speech hearing threshold or speech intelligibility (SI) better than 35 dB is classified as a socially acceptable hearing level (SAHL), while $SI \geq 35$ dB is classified as a socially unacceptable hearing level (SIHL). Discrimination scores are always noted but were not evaluated in the present study.

MATERIAL

Since January 1976 the data on all operations performed on the middle ear and mastoid have been computerized. The operations were performed on 770 (382 females, 388 males) patients (Table I). From January 1976 to December 1979 data on 952 miscellaneous operations on the ear were collected (Table II). During that time 131 patients were operated upon twice, 24 patients three times, and one patient four times. The mean age at the first operation was 40.9 years (range 7 months to 78 years). It is clear from Table II that reconstructive surgery was common. Grafting of the eardrum was performed at 542 operations (56.9 % of the material) and in 195 (20.5 %) of these operations myringoplasty was the only procedure. The last group, "other operations" comprised mainly of explorative tympanotomies, such as a second look after operation for cholesteatoma or a search for fistula in

Table I. *Age distribution of the material at first operation.*

Age (years)	No. of patients
0-10	38
11-20	65
21-30	112
31-40	136
41-50	152
51-60	185
61-70	69
71-80	13
Total	770

Table II. *Type and frequency of operations performed January 1976 - December 1979.*

Type of operation	Number	Frequency (%)
Myringoplasty	195	20.5
Tympanoplasty A (Ossiculoplasty included)	168	17.6
Tympanoplasty B (Ossiculoplasty not included)	88	9.2
Total reconstruction	91	9.6
Stapedectomy	151	15.8
Ossiculoplasty	117	12.3
Mastoidectomy	11	1.2
Radical mastoidectomy	35	3.7
Others	96	10.1
Total	952	100.0

sudden deafness. This group also included operations for congenital abnormalities. The presented data results were those available in February 1980.

RESULTS

Follow-up programme

Data on hearing and healing after various surgical procedures were summarized every second month and presented as demonstrated in Table III. The table exemplifies the results of myringoplasty and from the 12-month column is seen that 25 (89 %) out of 28 patients had an air-bone gap within 0-20 dB one year after the operation. These data could easily be compared to the preoperative condition as seen in the table. The same 12-month column shows that 25 (86 %) out of 29 patients had intact eardrums one year after surgery. One patient was too young to have his hearing examined with pure-tone audiometry, which explains the difference between the numbers of patients in the hearing and healing evaluation. The figures given in Table III denote the actual standards of the surgery at the department and were used in the preoperative evaluation and for information to patients of the risks and prospects of success of the operations offered. Corresponding summaries are presented for all the surgical procedures (Appendix, forms 5,6 and 7).

Annual production control programme

Removal of cholesteatomatous disease

The localisation, frequency and occurrence of cholesteatoma in different age groups and at different follow-up operations are given in Tables IV and V. It is clear from Table IV that of 80 patients subjected to a second-look operation residual cholesteatoma was found in 23 (28.8 %). Of the 11 patients hitherto subjected to a third-look residual disease has been found in only one. Residual cholesteatoma was found more often in children (50 %), and most frequently in the middle ear, which was the only localisation in 56.5 % (Table V).

Table IV. *Frequency and distribution of cholesteatoma among different age groups and follow-up surgery 1976-79.*

	Total		< 16 years		16-65 years		> 65 years	
	abs	%	abs	%	abs	%	abs	%
Primary op	161	100	28	100	120	100	13	100
Second look	23/80	28.8	7/14	50.0	15/64	23.4	1/2	50
Third look	1/11	9.0	0/4	0	1/6	16.7	0/1	0

Table V. *Site of cholesteatoma at first and second operation 1976-79.*

	middle ear		mastoid		both local	
	abs	%	abs	%	abs	%
Primary op	50	31.1	23	14.3	88	54.6
Second look	13	56.5	3	13.0	7	30.5

Healing of the tympanic membrane

All grafting was done with temporal fascia and underlay-technique (Storrs, 1961) and 306 (56.5 %) of the 542 patients who had had an eardrum grafted were examined 6 months later at routine follow-up. Myringoplasty alone had been done in 195 patients and 109 (55.9 %) of them were examined at the 6-month-follow-up. The take-rate is given in Table VI.

In order to find out whether the figures given in Table VI hold also for the total material, we also analysed the postoperative results in those patients examined outside the appointed 6-month-control. Only one of the 236 patients could not be traced. The results of the 235 patients are given in Table VII. Out of these 235 patients, 204 were registered in the 2nd, 12th or 24th month data control, which means that results of 94 % of the operations in which eardrum grafting had been performed were available in the data files. The other patients had to be up-dated manually. The reasons why the patients had not been registered

Table VI. *Healing of tympanic membrane six months after operation.*

Op year	All operations with ear drum grafting		Myringoplasty only	
	No.	%	No.	%
1976	70/102	69	26/43	60
1977	70/82	85	16/21	76
1978	76/84	90	33/35	94
1979	33/38	87	9/10	90

Table VII. *Healing of tympanic membrane in patients outside 6-month-data control. Observations 1-24 months after operation.*

Op. year	All operations with ear drum grafting		Myringoplasty only	
	No.	%	No.	%
1976	27/35	77	11/15	73
1977	47/61	77	16/25	64
1978	53/61	87	19/22	86
1979	70/78	90	20/23	87

in the 6-month-control were as follows: 52 patients had been subjected to a re-operation on the same ear, almost always tympanoplasty B-operations; 8 patients had moved outside our receiving area; in 31 patients, operated upon in 1979, too short a time had elapsed, and 144 patients had not been after-examined within the proposed time limit, i.e. 6 months $\pm$ 1 month.

The annual production control shows that in 109 out of 122 patients (89 %) operated upon during 1978 and 1979 the eardrums had healed at the 6-month-control (c.f. Table VI). These 122 cases were analysed further for any relation between peroperative condition of the ears and the healing of the eardrums. In Table VIII is shown that the take-rate was lower in wet ears than in dry

Table VIII. *Peroperative condition and effect on healing of the tympanic membrane six months after operation 1978-79. p-values according to Fisher's exact test with a two-sided alternative.*

Peroperative state	Healing		
	No.	%	
Normal mucous membrane	76/82	93	p = 0.16
Pathol mucous membrane	33/40	83	
Dry middle ear	90/97	93	p = 0.05
Mucoid/purulent secretion	19/25	76	

Table IX. *Relation between peroperative secretion and wound infection in all tympanoplastic procedures 1978-79. p-value according to Fisher's exact test with a two-sided alternative.*

Peroperative secretion	Wound inf. in postop. period		
	No.	%	
None	2/97	2.1	p = 0.002
Mucoid/purulent	6/25	24	

Table X. *Wound infection and healing after tympanoplastic operations 1978-79. p-values according to Fisher's exact test with a two-sided alternative.*

Wound inf. in postop. period	Healing 6 months postop.		
	No.	%	
None	105/114	92	p = 0.009
Wound inf.	4/8	50	

ears. But no such difference was seen between ears with and without affection of the mucous membrane.

Table IX shows the relation between peroperative secretion and postoperative wound infection in the same material. As seen, 24 % of those with a peroperative secretion also had a postoperative wound infection compared with only 2 % of those without peroperative discharge.

Table X shows that only 50 % of those with a postoperative wound infection had a healed eardrum at the 6-month-control.

Hearing after stapedectomy

Table XI gives the annual production control of hearing in patients operated upon with stapedectomy during 1976. Corresponding lists regarding hearing are produced annually also for other types of surgical procedures.

From Table XI is seen that 19 of the 41 operated patients attended to the 12-month postoperative control, i.e. they were re-examined within 12 ± 2 months after operation. The examination revealed that 18 (94.74 %) had an air-bone gap within 0-20 dB compared with 3 (15.79 %) preoperatively. Further down in the 12-month column it is seen that in 9 patients bone conduction had improved and that 8 had a socially acceptable hearing level, as tested with speech audiometry.

Table XII shows a summary of the 6-month-control results covering the period 1976 - 1979. A uniform technique was used during this period, viz. steel/platinum wire, according to House, placed on temporalis fascia. Seventy-three (48.3 %) of the 151 who had been operated upon with stapedectomy (c.f. Table II) had attended this control and 62 (84.9 %) patients had an air-bone closure within 0-20 dB. In order to find out whether the figures in Table XII are valid also for all the patients operated upon with stapedectomy, the postoperative results in those patients (78) examined outside the proposed 6-month-control were analysed.

Postoperative reports with hearing tests within 1-36 months are summarized in Table XIII. Data on 66 of these patients had been registered in the 2-, 12-, 24- or 36-month data control which means that data on the hearing ability results after 92 % of the stapedectomy operations were available in the data files. The other patients were updated manually. The reasons why the

Table XI. *Hearing figures for the 1976 stapedectomy group.*

ABC	preop			all op			2 mo			6 mo			12 mo		
	abs	%		abs	%		pre	abs	%	pre	abs	%	pre	abs	%
0-10 dB	1	2.44		1	2.70	24	64.86	1	4.00	12	48.00	1	5.26	9	47.37
0-20 dB	7	17.07		7	18.92	34	91.89	3	12.00	21	84.00	3	15.79	18	94.74
> 20 dB	34	82.93		30	81.08	3	8.11	22	88.00	4	16.00	16	84.21	1	5.26
B.C.															
Better						19	51.35			6	24.50			9	47.37
Unchanged	41			37		18	48.65	25		19	76.00	19		10	52.63
Worse						0				0				0	
Deaf ear						0				0				0	
Not perf						0				0				0	
S.I.															
SAHL	1	2.86								0	00			8	66.67
SIHL	34	97.14								12	100			4	33.33

patients had not been registered in the 6-month-control were as follows: 3 patients had undergone re-operation; for 12 patients, operated upon during 1979 too short a time for a 6-month-control had elapsed and the remaining 63 patients fell outside the preset time limit, i.e. 6 months $\pm$ 1 month.

It is clear from Table XIII, that the results in those who attended the 6-month-control (c.f. Table XII) may be regarded as representative of the results of the whole material.

Table XII. *Hearing 6 months after stapedectomy 1976-79 in 73 patients.*

	preoperatively		6 months control	
	No.	%	No.	%
ABG 0-20	9	12.3	62	84.9
> 20	64		11	
BC better (> 10 dB)			10	13.7
unchanged			63	
worse				

Table XIII. *Hearing results after stapedectomy in patients outside 6-month-data control. Observations 1-36 months after operation.*

	preoperatively		postoperatively	
	No.	%	No.	%
ABG 0-20	10	12.8	65	83.3
	68		13	
BC better (>10 dB)			14	17.9
unchanged			62	
worse (> 10 dB)			2	

Table XIV. *Hearing gain 6 months after ossicular reconstruction with different collumellisation techniques in patients with an intact eardrum at time of the control. Number of operations within brackets.*

	MSA(21)		SBL(70)		MFPA(10)		LBL(27)		LCL(28)	
	No.	%	No.	%	No.	%	No.	%	No.	%
ABG										
0-10 preop	1		1		1		1		1	
postop	4	19	19	27	3	30	1	3.7	3	11
0-20 preop	5		18	26	4		5		3	
postop	16	76	48	69	7	70	13	48	10	36

Hearing after ossiculoplasty

The hearing gain 6 months after reconstruction with various collumellisation techniques in patients who then had an intact eardrum is given in Table XIV, where the results from all the four years are pooled in order to get sufficient material for comparison. Of the patients with an intact stapes a "successful" air-bone closure was achieved in 76 % with a malleo-stapedical assembly (MSA) and in 69 % with a short bone L (SBL) columella, which also is called "slipper"-interposition. Of patients where the superstructures of the stapes were missing, an air-bone closure within 20 dB was found in 70 % for the malleo-footplate assembly (MFPA), in 48 % with the long bone L (LBL) columella and only in 36 % with the long cartilage L (LCL) columella.

DISCUSSION

The computerized system described can be readily adapted and suits the requirements of any ENT-clinic. The data forms have proved to be adequate and easy to handle. Our experience has shown that the time they take to be filled in is virtually negligible, especially since the surgeon does not have to consult a special manual for code numbers. Of the computer systems mentioned, only the one developed by Strauss et al. (1977) meets this requirement.

Systems where the surgeon himself punches his card (Shea, 1958; Smyth, 1976a) or places marks on optical scanning sheets (Ginsberg et al., 1978; White & Uhler, 1978) reduce the risks of errors in the transfer of the data. It is our opinion, however, that the in-built check systems (Fig. 1) compensate the extra step in our data handling procedures.

The idea of having the data processed at a computing center outside the clinic has several advantages. Although many of the University clinics have their own computers, this is not so in most ENT-clinics. Furthermore, the computer programmer is usually available only when the system is started up. Experience has taught us that close cooperation with the computer programmer is essential in a project of this type. The cooperation must be continuous in order to adapt the programme to changes in techniques, materials and standards of evaluation or changes considered important from a clinical as well as a scientific point of view.

As pointed out by White & Uhler (1978), the programme should be prospective, since it is difficult to get accurate and complete information in a retrospective investigation. Moreover, a retrospective study is so tedious that it usually tends to become a "once in a life-time" project. A prospective study also means that certain routines must be strictly observed. Uniform information to patients and personnel are positive spin-off effects. In that respect we have tried to define the interval between surgery and postoperative controls more exactly than usually practised in order to get better information about long-term results, which many authors have asked for (Spector et al., 1973; Donald & Baker, 1979).

The follow-up programme was designed to provide a ready survey of the state of hearing and healing of patients subjected to various operations. With the deleterious effect of chlorhexidin in mind (Bicknell, 1971) such a follow-up programme would soon detect similar injury to the inner ear by other agents or factors.

Patients failing to attend an appointment for a follow-up are registered on a separate sheet. Especially cholesteatoma patients missing a control are important in this respect. In this way the follow-up programme can be compared with a cancer-register. The records on the "missing" patients are then looked through by

the secretary and surgeon so that appropriate measures can be taken.

Since 1971 cholesteatomas in our clinic have been operated upon with a closed technique (CAT) in about 80 % of the cases and with an open technique (radical or modified radical operation) in the remaining 20 %. With the growing awareness of residual disease and the inspiration by Sheehy & Crabtree's (1973) staging procedure, we started the following programme in 1973: If the primary operation is a CAT, we plan a second look within 6 - 9 months. If there is a residual cholesteatoma, we have a third look after an equal interval. If cholesteatoma is found even the third time, treatment is extended to a radical/modified radical operation. The findings in these procedures are computerized and presented as in Tables IV and V. The frequency (28.8 %) of residual cholesteatoma, the higher incidence of residual cholesteatoma in children (50.0 %) and their sites (56.5 % in the middle ear) agree with what has been reported in other re-operated materials (Smyth, 1976c; Sheehy et al., 1977).

The computer programme soon revealed that our graft take-rate (c.f. Table VI) did not compare favourably with those on record (Örtegren, 1964; Palva, 1969; Hough, 1970; Strahan et al., 1971; Rahnasto, 1979) particularly in the myringoplasty group. These operations are performed mainly by less experienced surgeons, e.g. residents in training. In 1977 we therefore improved our training programme by including among other things a higher degree of supervision with increase in the take-rate as a result. Since the take-rate depends to such a large extent on the skill of the surgeon, other relations considered in this presentation date back only to 1978 and 1979.

In most published materials myringoplasties are performed only on dry ears. In Beck's (1977) series also moist ears were included and the failure rate in that group was only slightly higher. Smyth (1976b), on the other hand, reported no difference except for small perforations, for which the failure rate was higher in wet ears. In our series the take-rate was lower in wet ears (c.f. Table VIII). It is not known whether this was due to the infection itself or to technical problems often encountered in draining ears with more profuse bleeding. Although the material was small a close relation was found between peroperative secretion and postoperative wound infections (c.f. Table IX). Wound

infection meant a higher failure rate (c.f. Table X).

There is no generally accepted way for presenting hearing after ear surgery. Most surgeons use some form of success rate founded on ABG-closure. In 1965 the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology (AAOO) advocated presentation of ABG reduced to 10 dB or less, 20 dB or less and 30 dB or less. Closure of ABG within the interval 0-10 dB is practised by Hough (1970), Pfaltz et al. (1975) and Smyth (1976b); within the interval 0-15 dB by Cody & Taylor (1973); and within the interval 0-20 dB by Sheehy & Crabtree (1973), Spector et al. (1973) and Donald & Becker (1979). A graphic presentation is used by Austin (1971) and Palva et al. (1973). The last mentioned authors also use the difference between pre- and postoperative values for a therapeutic efficiency curve, which gives a better view of the figures when comparing different materials and surgical methods. With an air-bone closure within 20 dB in 85 % of the stapedectomies our results estimated 6 months after operation seem to be in agreement with those on record (Hammond, 1976; Strauss & Strahl, 1976; Palva et al., 1977).

Most cited surgeons follow the advice given by the AAOO (1965) and use postoperative air conduction and preoperative bone conduction when calculating the postoperative ABG. In our material, however, we always used the postoperative bone conduction (c.f.

Tables III, XI, XII, XIII and XIV). This is because of the frequent BC-shift after middle ear surgery as also described by McConnell & Carhardt (1952), Rosen et al. (1959), Austin (1978) and Harder et al. (1979).

For several reasons measurement of bone conduction is the crucial point in pure-tone audiometry because of lack of generally accepted calibration standards, fragility of bone vibrators and, above all, masking problems that always exist, especially in patients with bilateral conductive disease. Hearing gain calculated on change in air conduction alone is the most reliable measurement, as shown by Harder et al. (in press) and should be used more often. For obvious reasons, however, bone conduction must always be considered since also unsuccessful surgery due to cochlear injury in association with the operation must be taken into account (Smyth, 1977).

Broadly speaking the closure of ABG is a measure of the efficiency with which the surgeon has solved the conductive

problems in the middle ear. The patient, on the other hand, is often more interested in his ability to hear after the operation. With the Swedish word material (Lidén & Fant, 1954; Johansson, 1966) a speech reception threshold better than 35 dB usually means an acceptable level for speech communication. SI better than 35 dB is therefore termed SAHL in accordance with the terminology used by Pfaltz et al. (1975). Similar classifications have been described by Donald & Baker (1979), while Strauss (1976) considers the correlation between speech reception thresholds and pure-tone average for speech frequencies so good that SI measurements are unnecessary. Some other authors classify hearing with pure-tone average values above 30 dB as socially adequate (Tos, 1972; Cody & Taylor, 1973).

A few main items have been chosen to demonstrate the capacity of the annual production control programme. Many more results are available, but for the clinical evaluation some relations require a longer follow-up and in some cases the materials are not yet large enough for statistical evaluation.

The manual check of patients outside the predetermined interval shows that the computerized results are representative of all operations (c.f. Tables VI, VII, XII and XIII). One of the most important things is of course that the figures are based on a standardized system so that we can evaluate the outcome of our own activity in ear surgery. The stored information, however, means a data pool offering possibilities for several clinics to get relevant statistical data much sooner than with other more conventional follow-up programmes.

In conclusion the presented data system has proved to function well regarding collection and handling of data from both a clinical and administrative point of view. The presented data are currently used in the clinic's production control. From a scientific standpoint the more well-defined follow-up offers future possibilities for critical analysis. As in most presented clinical materials many patients did not come to proposed controls. In spite of that, the presented data results showed to be representative

ACKNOWLEDGEMENT

The author wishes to thank Bertil Sjöstedt, Lund Computing Center, for his never failing patience and interest in programming and operating the computer throughout the project.

ZUSAMMENFASSUNG

Es wird ein Computer-basiertes Verfahren zur Registrierung der Resultate nach mikrochirurgischen Eingriffen am Mittelohr vorgestellt. Besonders für diesen Zweck angefertigte Formblätter werden zu bestimmten Zeitpunkten ausgefüllt, nämlich im Zusammenhang mit der Operation, zwei und sechs Monate danach und darauf einmal jährlich in den folgenden fünf Jahren nach der Operation. Die Datenverarbeitung erfolgt in einem Univac 1100-80 Computer an Hand eines für diesen Zweck entwickelten FORTRAN-Programmes. Ein laufendes Kontrollprogramm liefert aktuelle Information betreffs der Hörfunktion und Abheilung nach den verschiedenen Arten von mikrochirurgischen Eingriffen. Ein zweites Programm zur jährlichen Produktionskontrolle gibt im Einzelnen Auskunft über verschiedene statistische Abhängigkeiten, wie z.B. Operationsresultate bei sezernierenden Ohren, Vorkommen von Restcholesteatomen u.s.w. In der Diskussion wird auf unsere vierjährige Erfahrung mit dem Beschriebenen Verfahren sowie auf die sich daraus anbietende Möglichkeit zu erweiterter Information eingegangen.

REFERENCES

- Austin, D. 1971. Ossicular reconstruction. *Arch Otolaryngol* 94, 525.
- 1978. Sound conduction of the diseased ear. *J Laryngol Otol* 92, 367.
- Beck, C. 1977. Erfahrungen mit der Unterlegetechnik bei Tympanoplastik Typ I. *Arch Otorhinolaryngol* (NY) 214, 361.
- Bicknell, P. 1971. Sensorineural deafness following myringoplasty operations. *J Laryngol Otol* 85, 957.
- Cody, T. & Taylor, W. 1973. Tympanoplasty: long-term hearing results with incus grafts. *Laryngoscope* 83, 852.
- Donald, P. & Baker, S. 1979. Hearing results following attico-tomy. *Laryngoscope* 89, 195.
- Ginsberg, I., Hoffman, S., Stinziano, G. & White, T. 1978. Stapedectomy - in depth analysis of 2405 cases. *Laryngoscope* 88, 1999.
- Hammond, V. 1976. The indications for stapedectomy. *J Laryngol Otol* 90, 23.
- Harder, H., Ekvall, L., Kylén, P. & Arlinger, S. 1979. Hearing gain calculations after stapedectomy. *Acta Otolaryngol* (Stockh), Suppl. 360, 158.
- Harder, H., Jerlvall, L., Kylén, P. & Ekvall, L. 1980. Calculation of hearing results after tympanoplasty. *Clin Otolaryngol*. (in press).
- Harris, S., Bylander, A. & Reimer, Å. 1977. Datakontroll vid mellanörekirurgi. *Svensk Otolaryngologisk Förening* 53. (in Swedish).
- Hough, J.V.D. 1970. Tympanoplasty with the interior fascial graft technique and ossicular reconstruction. *Laryngoscope* 80, 1385.
- Johansson, B. 1966. Personal communication. Department of Technical Audiology, The Royal Institute of Technology, Stockholm, Sweden.
- Lidén, G. & Fant, G. 1954. Swedish word material for speech audiometry and articulation test. *Acta Otolaryngol* (Stockh), Suppl. 116.
- McConnell, F. & Carhardt, R. 1952. Influence of fenestration surgery on bone conduction measurements. *Laryngoscope* 62, 1267.
- Örtegren, U. 1964. Myringoplasty: Four years' experience of temporal fascia grafts. *Acta Otolaryngol* (Stockh), Suppl. 193.

- Palva, T. 1969. Surgery of the chronic ear. *Ear Nose Throat J* 48, 44.
- Palva, T., Palva, A. & Kärjä, J. 1973. Ossicular reconstruction in chronic ear surgery. *Arch Otolaryngol* 98, 340.
- Palva, T., Kärjä, J. & Palva, A. 1977. Otosclerosis surgery. *Acta Otolaryngol* (Stockh) 83, 328.
- Pfaltz, C.R., Pfaltz, R. & Schmid, P. 1975. Reconstructive surgery in chronic otitis media. Statistical analysis of long-term results. *ORL* 37, 257.
- Rahnasto, J. 1979. Long-term results of myringoplasty and tympanoplasty. Academic dissertation, Helsinki, Finland.
- Rosen, S., Bergman, M. & Grossman, I. 1959. Bone conduction thresholds in stapes surgery. *Arch Otolaryngol* 70, 365.
- Schmitt, H. & Naumann, H. 1960. Ein Vorschlag zur Dokumentation und Statistik der Ohroperationen. *Med Dokum* 4, 30.
- Shea, J. 1958. Fenestration of the oval window. *Ann Otol Rhinol Laryngol* 67, 932.
- 1960. An IBM record card for stapes surgery. *Ann Otol Rhinol Laryngol* 69, 280.
 - 1964. IBM Port-A-Punch card system for otosclerosis surgery. *Laryngoscope* 74, 245.
- Sheehy, J. & Crabtree, J. 1973. Tympanoplasty: Staging the operation. *Laryngoscope* 83, 1594.
- Sheehy, J., Brackmann, D. & Graham, M. 1977. Cholesteatoma surgery: residual and recurrent disease. *Ann Otol Rhinol Laryngol* 86, 451.
- Smyth, G. 1976a. The surgical treatment of chronic otitis media in children. *J Otolaryngol* 5, 446.
- 1976b. Tympanic reconstruction. *J Laryngol Otol* 90, 713.
 - 1976c. Postoperative cholesteatoma in combined approach tympanoplasty. *J Laryngol Otol* 90, 597.
 - 1977. Sensorineural hearing loss in chronic ear surgery. *Ann Otol Rhinol Laryngol* 86, 3.
- Spector, G., Pratt, L. & Randall, G. 1973. A clinical study of delayed reconstruction in ossicular fractures. *Laryngoscope* 83, 837.
- Storrs, L.A. 1961. Myringoplasty with the use of fascia grafts. *Arch Otolaryngol* 74, 65.

- Strahan, R.W., Ward, P.H., Acquarelli, M. & Jafek, B. 1971. Tympanic membrane grafting; analysis of materials and techniques. *Ann Otol Rhinol Laryngol* 80, 854.
- Strauss, P. 1976. Erfassung und Auswertung audiometrischer Daten vor und nach Ohroperationen - Ein Vorschlag zur Standardisierung. *Laryngol Rhinol Otol* 55, 761.
- 1979. Das Hörvermögen nach Tympanoplastik. *HNO* 27, 217.
- Strauss, P. & Strahl, M. 1976. Spätergebnisse nach über 15 Jahren Stapedektomie. *Laryngol Rhinol Otol* 55, 217.
- Strauss, P., Wöhl, K., Dau, I. & Lippert, H. 1977. Ein Modell für verschiedene Grossrechnertypen zur Erfassung, Speicherung und Auswertung von Daten bei Ohroperationen. *Laryngol Rhinol Otol* 56, 878.
- The Committee on conservation of hearing of the American academy of ophthalmology and otolaryngology. 1965. Standard classification for surgery of chronic ear infection. *Arch Otolaryngol* 81, 204.
- Tos, M. 1972. Results of tympanoplasty with modified radical mastoidectomy. *Acta Otolaryngol* (Stockh) 74, 61.
- White, T. & Uhler, L. 1978. Procedures for preparation of otological and audiological data for computer analysis. *Laryngoscope* 88, 1836.
- Wullstein, H.L., Schmitt, H.G. & Naumann, H.W. 1959. Société internationale d'audiologie, IV^e Congrès Padova, Audin-Lyon.
- Wullstein, H., Bandtlow, O., Kreutle, O. & Schmitt, H. 1961. Erfahrungen bei der statistischen Auswertung gehörverbessernder Operationen mit dem IBM-Lochkartenverfahren. *Acta Otolaryngol* (Stockh) 54, 56.

Sten Harris, M.D.

University of Lund

ENT-Department

Malmö General Hospital

S-214 01 Malmö, Sweden

A P P E N D I X

MIDDLE EAR SURGERY

Form **1/A**ENT-Department
Malmö
Sweden

Patient no

Name

Date of control

Op no

PREOPERATIVE STATE

1. a) OP. EAR

right ☐ 1left ☐ 2

AUDIOMETRY

Bone	Air	ABG	SI	Disc

2. a) AIR-BONE GAP (ABG)

0-10 dB ☐ 111-20 dB ☐ 221-30 dB ☐ 331-40 dB ☐ 441-60 dB ☐ 5not measurable ☐ 6not performed ☐ 7

2. b) BONE CONDUCTION

measurable ☐ 2deaf ear ☐ 4not performed ☐ 5

4. SPEECH INTELLIGIBILITY (SI)

SAHL (< 35 dB) ☐ 1SIHL (≥ 35 dB) ☐ 2not performed ☐ 3

Date of op

--	--	--	--	--	--	--	--	--	--

Surg

--	--

Form

18

PEROPERATIVE STATE

5. TYMPANIC MEMBRANE A

- intact, movable ☐ 1
- intact, not movable ☐ 2
- adhesive ☐ 3
- small perf (<25%) ☐ 4
- large " (25-75%) ☐ 5
- total " (>75%) ☐ 6
- combination 3 + 4 ☐ 7
- combination 3 + 5 ☐ 8

6. TYMPANIC MEMBRANE B

- normal ☐ 1
- tympanosclerosis ☐ 2
- scarred ☐ 3
- retraction ☐ 4
- combination ☐ 5
- other ☐ 6

7. OSSICULAR CHAIN

- intact, movable ☐ 1
- dislocation ☐ 2
- interruption, inc-stap joint ☐ 3
- " stap, superstruct ☐ 4
- fixed stap, otosclerosis ☐ 5
- " " , tympanosclerosis ☐ 6
- fixed lateral chain ☐ 7
- columella, functioning ☐ 8
- " non functioning ☐ 9
- other ☐ 10

8. MUCOSAL LINING

a) middle ear

- normal ☐ 1
- thickened ☐ 2
- " , granulated ☐ 3
- " , polypous ☐ 4

b) air-cell system

- normal ☐ 1
- thickened ☐ 2
- " , granulated ☐ 3
- " , polypous ☐ 4
- not investigated ☐ 5

9. DISCHARGE

- none ☐ 1
- mucoid ☐ 2
- purulent ☐ 3

10. BONY ANNULUS

- normal ☐ 1
- eroded ☐ 2
- surgical destruction ☐ 3
- combination ☐ 4

11. CANAL WALL

- normal ☐ 1
- atretic ☐ 2
- eroded ☐ 3
- surgical destruction ☐ 4
- combination ☐ 5

12. CHOLESTEATOMA/SQUAMOUS EPITHELIUM

a) middle ear

- none ☐ 1
- squamous epithelium ☐ 2
- cholesteatoma ☐ 3
- not classified ☐ 4

b) air-cell system

- none ☐ 1
- squamous epithelium ☐ 2
- cholesteatoma ☐ 3
- not classified ☐ 4
- not investigated ☐ 5

13. SPECIAL FINDINGS

- none ☐ 1
- fistula of semicirc.canal ☐ 2
- dura exposed ☐ 3
- sigmoid sinus exposed ☐ 4
- facial nerve exposed ☐ 5
- combination ☐ 6
- Eustachian tube closed ☐ 7
- other ☐ 8

SURGICAL PROCEDURESForm **1 C**

14. TYMPANIC MEMBRANE

- none ☐ 1
fascia ☐ 2
perichondr ☐ 3
other procedure ☐ 4

15. OSSICULAR CHAIN

- none ☐ 1
incus transposition ☐ 2
MSA (malleostapedial assembly) ☐ 3
MFPA (malleus footplate
assembly) ☐ 4
SBL (short bone L = "slipper
interposition) ☐ 5
LBL (long bone L) ☐ 6
LCL (long cartilage L) ☐ 7
stapedectomy - wire ☐ 8
" - other ☐ 9
other procedure ☐ 10

16. MUCOSAL LINING

- none ☐ 1
gel film ☐ 2
silastic sheeting ☐ 3
other material ☐ 4

17. AIR-CELL SYSTEM

- none ☐ 1
simple mastoidectomy ☐ 2
radical " ☐ 3
revision of " ☐ 4
posttympanotomy ☐ 5
other procedure ☐ 6

18. BONY ANNULUS

- none ☐ 1
bone ☐ 2
cartilage ☐ 3
other procedure ☐ 4

19. CANAL WALL

- none ☐ 1
bone ☐ 2
cartilage ☐ 3
widened ☐ 4
other procedure ☐ 5

20. "MIDDLE EAR PACKING"

- none ☐ 1
gelfoam ☐ 2
other material ☐ 3

21. COMPLICATIONS

- none ☐ 1
perilymphatic leakage ☐ 2
dura exposed ☐ 3
liquor fistula ☐ 4
sigmoid sinus haemorrhage ☐ 5
jugular bulb - " - ☐ 6
facial nerve injury ☐ 7
combination ☐ 8
other ☐ 9

22. TYPE OF OPERATION

- Myringoplasty ☐ 1
Tympanoplasty A
(ossiculoplasty included) ☐ 2
Tympanoplasty B
(ossiculoplasty not included) ☐ 3
"Total reconstruction" ☐ 4
Stapedectomy ☐ 5
Ossiculoplasty ☐ 6
Mastoidectomy ☐ 7
Radical mastoidectomy ☐ 8
Other operation ☐ 9

MIDDLE EAR SURGERY

ENT-Department
Malmö
Sweden

Form 2

Date of control

POST OP CONTROL 0, 2

Patient no

Name

Op no

POSTOPERATIVE STATE - 2 months

AUDIOMETRY

op ear

Bone	Air	ABG

1. a) OP. EAR

right ☐ 1left ☐ 2

2. a) air-bone gap (ABG)

0-10 dB ☐ 111-20 dB ☐ 221-30 dB ☐ 331-40 dB ☐ 441-60 dB ☐ 5not measurable ☐ 6not performed ☐ 7

b) bone conduction

better(> 10 dB) ☐ 1unchanged ☐ 2worse(>10 dB measurable) ☐ 3deaf ear ☐ 4not performed ☐ 5

5. TYMPANIC MEMBRANE A

intact, movable ☐ 1intact, not movable ☐ 2adhesive ☐ 3small perf (<25%) ☐ 4large " (25-75%) ☐ 5total " (>75%) ☐ 6combination 3 + 4 ☐ 7" 3 + 5 ☐ 8

6. TYMPANIC MEMBRANE B

normal ☐ 1tympanosclerosis ☐ 2scarred ☐ 3retraction ☐ 4combination ☐ 5other ☐ 6

11. CANAL WALL

normal ☐ 1not intact ☐ 2atretic ☐ 3combination ☐ 4other ☐ 5

21. COMPLICATIONS

none ☐ 1tinnitus ☐ 2vertigo ☐ 3facial nerve paralysis ☐ 4cholesteatoma ☐ 5combination ☐ 6other ☐ 723. WOUND INFECTION IN POST OP PERIOD
(within 2 weeks)no ☐ 1yes ☐ 2

9. DISCHARGE

none ☐ 1mucoid ☐ 2purulent ☐ 3

MIDDLE EAR SURGERY

ENT-Department

Malmö

Sweden

Form 3

Date of control

POST OP CONTROL

0 6

Patient no

Name

Op no

POSTOPERATIVE STATE - 6 - months

AUDIOMETRY

Bone	Air	ABG

1. a) OP. EAR

right

☐ 1

left

☐ 2

2. a) air-bone gap (ABG)

0-10 dB

☐ 1

11-20 dB

☐ 2

21-30 dB

☐ 3

31-40 dB

☐ 4

41-60 dB

☐ 5

not measurable

☐ 6

not performed

☐ 7

b) bone conduction

better (>10 dB)

☐ 1

unchanged

☐ 2

worse(>10 dB measurable)

☐ 3

deaf ear

☐ 4

not performed

☐ 5

5. TYMPANIC MEMBRANE A

intact, movable

☐ 1

intact, not movable

☐ 2

adhesive

☐ 3

small perf (<25%)

☐ 4

large " (25-75%)

☐ 5

total " (>75%)

☐ 6

combination 3 + 4

☐ 7

combination 3 + 5

☐ 8

11. CANAL WALL

normal

☐ 1

not intact

☐ 2

atretic

☐ 3

combination

☐ 4

other

☐ 5

21. COMPLICATIONS

none

☐ 1

tinnitus

☐ 2

vertigo

☐ 3

facial nerve paralysis

☐ 4

cholesteatoma

☐ 5

combination

☐ 6

other

☐ 7

9. DISCHARGE

none

☐ 1

mucoid

☐ 2

purulent

☐ 3

6. TYMPANIC MEMBRANE B

normal

☐ 1

tympanosclerosis

☐ 2

scarred

☐ 3

retraction

☐ 4

combination

☐ 5

other

☐ 6

MIDDLE EAR SURGERY

Patient no

--	--	--	--	--	--	--	--	--	--

ENT-Department

Malmö

Sweden

Form

4

Name _____

Date of control

--	--	--	--	--

Op no

--

POST OP CONTROL

--	--

POSTOPERATIVE STATE - 12 - 24 - months

AUDIOMETRY

1. a) OP. EAR

Bone	Air	ABG	SI	Disc

right

1

left

2

2. a) air-bone gap (ABG)

0-10 dB

--

 1

11-20 dB

--

 2

21-30 dB

--

 3

31-40 dB

--

 4

41-60 dB

--

 5not measurable
not performed

--

 6

--

 7

b) bone conduction

better (>10 dB)

--

 1

unchanged

--

 2

worse(>10 dB measurable)

--

 3

deaf ear

--

 4

not performed

--

 5

5. TYMPANIC MEMBRANE A

intact, movable

--

 1

intact, not movable

--

 2

adhesive

--

 3

small perf (<25%)

--

 4

large " (25-75%)

--

 5

total perf (>75%)

--

 6

combination 3 + 4

--

 7

" 3 + 5

--

 8

6. TYMPANIC MEMBRANE B

normal

--

 1

tympanosclerosis

--

 2

scarred

--

 3

retraction

--

 4

combination

--

 5

other

--

 6

11. CANAL WALL

normal

--

 1

not intact

--

 2

atretic

--

 3

combination

--

 4

other

--

 5

21. COMPLICATIONS

none

--

 1

tinnitus

--

 2

vertigo

--

 3

facial nerve paralysis

--

 4

cholesteatoma

--

 5

combination

--

 6

other

--

 7

4. SPEECH INTELLIGIBILITY (SI)

SAHL (< 35 dB)

--

 1SIHL ($\geq$ 35 dB)

--

 2

not performed

--

 3

9. DISCHARGE

none

--

 1

mucoid

--

 2

purulent

--

 3

22:1

MYRINGOPLASTY

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	5	20.	12	48.	4	15.	14	54.	5	18.	16	57.
0-20	13	52.	23	92.	12	46.	23	88.	16	57.	25	89.
>20	12		2		14		3		12		3	
BC WORSE	0	0.	1	4.	0	0.	1	4.	0	0.	1	4.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									10	42.	15	60.
SIHL									14		10	
EAR DRUM INTACT	1		24	92.	0		24	92.	0		25	86.
EAR DRUM PERF.	25		2		26		2		29		4	

22:2

TYMPANOPLASTY A

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	4	13.	1	4.	1	4.	0	0.	4	18.
0-20	8	25.	19	59.	5	22.	14	61.	3	14.	9	41.
>20	24		13		18		9		19		13	
BC WORSE	0	0.	0	0.	0	0.	2	9.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									1	5.	8	40.
SIHL									19		12	
EAR DRUM INTACT	16		29	91.	7		22	92.	3		20	87.
EAR DRUM PERF.	16		3		17		2		20		3	

22:3

TYMPANOPLASTY B

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	1		0		1		0		0		0	
0-20	1		3		1		1		0		0	
>20	6		4		0		0		0		0	
BC WORSE	0	0.	1	14.	0	0.	0	0.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									0		0	
SIHL									0		0	
EAR DRUM INTACT	3		7	100.	1		1	100.	0		0	0.
EAR DRUM PERF.	4		0		0		0		0		0	

22:4

TOTAL RECONSTRUCTION

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	1	5.	2	10.	1	5.	2	20.	0	0.
0-20	5	25.	3	15.	5	25.	8	40.	3	30.	2	20.
>20	15		17		15		12		7		8	
BC WORSE	0	0.	2	10.	0	0.	2	10.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	1	5.	0	0.	0	0.
SAHL									2	25.	2	22.
SIHL									6		7	
EAR DRUM INTACT	9		16	80.	10		15	71.	5		8	80.
EAR DRUM PERF.	11		4		11		6		5		2	

22:5

STAPEDECTOMY

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	15	68.	0	0.	10	67.	0	0.	10	67.
0-20	3	14.	19	86	2	13.	14	93.	1	7.	13	87.
>20	19		3		13		1		14		2	
BC WORSE	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									0	0.	9	64.
SIHL									13		5	
EAR DRUM INTACT	23		23		15		16		15		16	
EAR DRUM PERF.	0		0		1		0		1		0	

22:6

OSSICULOPLASTY

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	5	18.	0	0.	1	7.	0	0.	0	0.
0-20	2	7.	15	54.	2	13.	5	33.	1	6.	6	38.
>20	26		13		13		10		15		10	
BC WORSE	0	0.	0	0.	0	0.	1	7.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									0	0.	4	27.
SIHL									15		11	
EAR DRUM INTACT	27		28		14		13		16		16	
EAR DRUM PERF.	1		0		1		2		1		1	

22:7

MASTOIDECTOMY

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
0-20	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
>20	0		0		0		0		0		0	
BC WORSE	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									0	0.	0	0.
SIHL									0		0	
EAR DRUM INTACT	0		0		0		0		0		0	
EAR DRUM PERF.	0		0		0		0		0		0	

22:8

RADICAL MASTOIDECTOMY

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
0-20	3	43.	2	29.	2	40.	1	20.	0	0.	0	0.
>20	4		5		3		4		3		3	
BC WORSE	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
DEAF EAR	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
SAHL									0	0.	0	0.
SIHL									3		1	
EAR DRUM INTACT	3		7	100.	1		4	80.	2		3	100.
EAR DRUM PERF.	4		0		4		1		1		0	

22:10

OTHER OPERATION

ABS AND REL FREQUENCY

	PREOP		2 MO		PREOP		6 MO		PREOP		12 MO	
	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%	ABS	%
ABG												
0-10	4		3		2		1		2		3	
0-20	5		7		5		4		4		3	
>20	3		1		4		5		6		7	
BC WORSE	0	0.	0	0.	0	0.	0	0.	0	0.	0	0.
DEAF EAR	0	0.	1	13.	0	0.	1	11.	0	0.	2	20.
SAHL									0		1	
SIHL									8		6	
EAR DRUM INTACT	13		14		9		12		12		14	
EAR DRUM PERF.	1		0		3		0		3		1	

MIDDLE EAR MECHANICS AND EUSTACHIAN TUBE FUNCTION IN TYMPANOPLASTY

L. Andreasson and S. Harris

From the ENT Department, Malmö General Hospital, University of Lund, Malmö, Sweden

Abstract. In 100 patients with chronic otitis media, tubal function and volume was tested before operation. In a postoperative study on hearing and healing there was no positive correlation between these findings and the preoperative results. In 50 patients with healed ear drums, tubal function was retested in a pressure chamber with a flow volume technique. An improvement in Eustachian tube function could be demonstrated. These findings indicate that poor tubal function in chronic otitis media might be secondary to other factors responsible for the disease.

The debate concerning the role of the Eustachian tube function in middle ear surgery has been going on for many years. Several investigations have been described but the results differ widely. Miller & Bilodeau (1967), Holmquist (1968) and Siedentop et al. (1972) found better healing results in patients with good preoperative tubal function, as compared with those with impaired function. In investigations by Ekvall (1970), Lee & Schuknecht (1971) and Virtanen (1977) no such difference was found.

Using the test methods and equipment developed by the middle ear research group in Malmö, the present study was carried out with the following aims:

1. To find out if the tubal function of the volume of the cell system affects healing after surgery for chronic otitis media.
2. To find out if there is any change in tubal function when tested postoperatively.

METHODS

For preoperative tests the equipment used was that described by Andreasson & Ivarsson (1976) (Fig. 1). It consists of an airtight glass

syringe with a micrometer screw, hermetically connected via a three-way stopcock to a pressure transducer and a digital instrument. The ear and the measuring device form a closed system, whose pressure is variable. The syringe volume is shut off from the rest of the system during measurement of the pressure, making the total volume of the apparatus less than 1 ml. By changing the pressure in the system and instructing the patient to swallow, one can manometrically measure tubal function according to the aspiration–deflation method first described by Flisberg et al. (1963). With this equipment, Politzer's test, Valsalva's manoeuvre and Toynbee's test could also be performed and determination of the volume of the air-filled earspace could be made.

For the postoperative analysis the pressure chamber apparatus first described by Elner et al. (1971a) was used. The patient sits in a pressure chamber in which the pressure can be adjusted to over- or underpressure, and the measuring device consists of two identical flow meter systems (Fig. 2). One, "the ear flow meter system", is hermetically connected to the outer ear canal. Movement of the eardrum by changing the middle ear pressure (ΔP_m) produces a flow in the external ear canal and in the flow meter ($\dot{V}_{tm}$). By integrating the flow signal it is possible to record the volume displacement of the tympanic membrane (V_{tm}). This procedure is used for Valsalva's, Toynbee's and Politzer's tests. It is also possible to record the volume displacement of the tympanic membrane when the chamber pressure is

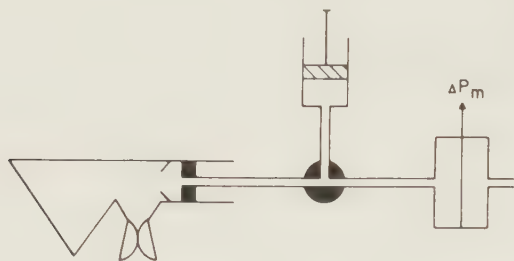


Fig. 1. Block diagram of equipment for preoperative testing.

changed (ΔP_{ch}) by using an adjustable reference system operating a separate flow meter—"the reference flow meter system". When the system is in proper balance, the airflow in the reference system ($\dot{V}_{ref}$) and that in the ear system ($\dot{V}_{ec}$) neutralize each other. Active equilibration of static over- and underpressure in the middle ear was studied by the decrease/increase in chamber pressure at ± 10 cmH₂O.

During each examination the number of deglutitions was limited to 10. The effect of the pressure equilibration was recorded as a change in the position of the ear drum (Fig. 2). This apparatus was also used to determine the initial middle ear pressure (Fig. 3). The recording is based on the fact that the movement velocity of the drum is maximal in its neutral position. By repeatedly changing the chamber pressure from -15 to $+15$ cmH₂O, during which time the patient is requested not to swallow, the drum is pushed outwards or inwards by the relative over- and underpressures created in the middle ear. In Fig. 3 the maximum velocity ($\dot{V}_{max}$) is noted at points *a* and *b*. At this moment the pressure in the middle ear is the same as that in the chamber. This pressure is defined as the initial middle ear pressure (P_{mi}) relative to the pressure outside the chamber.

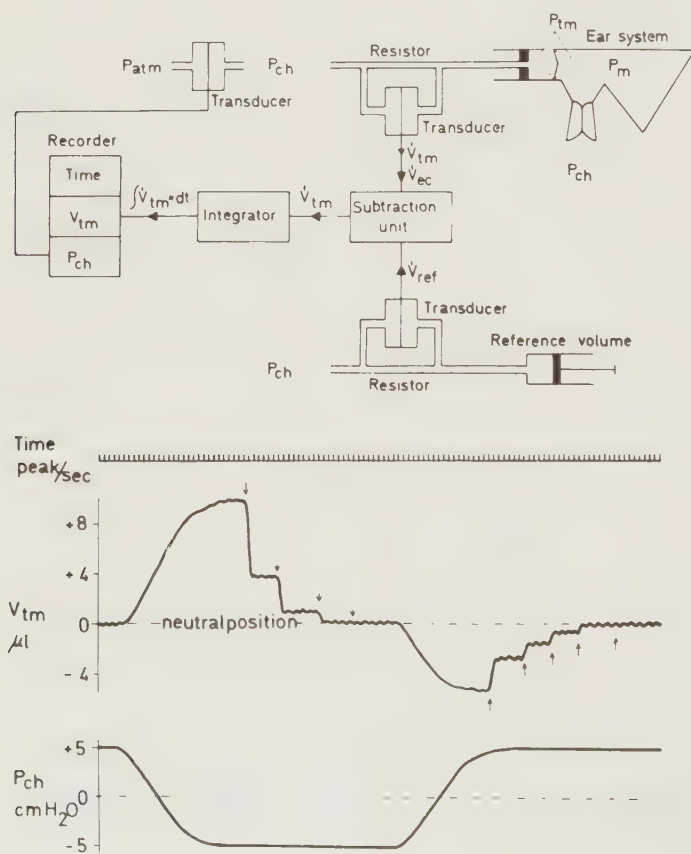


Fig. 2. Block diagram of the pressure chamber and flow meter systems.

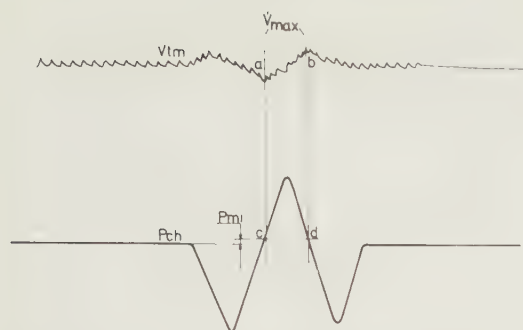


Fig. 3. Calculation of initial middle ear pressure, P_{mi} . $\dot{V}_{tm}$, velocity of the drum; P_{ch} chamber pressure. For performance see text.

For statistical evaluations the χ -square test was used.

Performance of test

A routine ENT examination was performed and the test ear was examined under an operating microscope. Only dry ears with central perforation of the drum were accepted and then only in patients who showed no signs of upper respiratory tract infection when tested or operated upon. The tests were done with the patient sitting upright.

After placing the polyethylene catheter with cuff in the outer ear canal, the system was checked for leakage. The tests were performed in the following order:

1. Politzer's test
2. Toynbee's test
3. Aspiration-deflation test at ± 10 cmH₂O and max. 10 deglutitions
4. Valsalva's test
5. Volume determination.

Postoperatively the catheter was applied in the same way and the tests were carried out in the following order with the patient sitting upright:

1. Initial middle ear pressure, P_{mi}
2. Valsalva's test
3. Toynbee's test
4. Aspiration-deflation test at ± 10 cmH₂O and max. 10 deglutitions
5. Compliance registration
6. In certain cases, "sniff test"

Table I. The age distribution of the material

Age	No. of patients
0-10	3
11-20	8
21-30	26
31-40	21
41-50	22
51-60	14
>60	6
Total	100

Hearing was tested with a pure-tone audiometer (Madsen OB 70) together with matched TDH 39 earphones, fitted with MX 41 AR cushions for air conduction. For bone conduction a bone vibrator from Radio Ear model B-71 was used. The audiometric zero for air-threshold was calibrated according to STAF, 1975. Mean air- and bone-threshold levels were calculated for the frequencies 500, 1000 and 2000 Hz. The difference between air and bone conduction is given as the air-bone gap (ABG).

Surgical technique and postoperative care

The operations were performed by four experienced surgeons using a uniform technique. Myringoplasty was done with dried temporalis fascia and underlay technique. By ossicular reconstruction defects in the ossicular chain were repaired. The materials used were autografts of ossicular remnants, ossicular homografts or septal cartilage.

Decongestant nosedrops were used for 10 days and phenylpropanolamine for at least 4 weeks or until the middle ear was aerated. The patients were instructed to perform Valsalva's manoeuvre when necessary.

Table II. Take rate in relation to aspiration capacity and Valsalva's test

	Pos. aspir.		Neg. aspir.	
	n	%	n	%
Healed/aspir. cap.	63/72	88	26/28	93
Healed/Vals. test	75/83	90	14/17	82

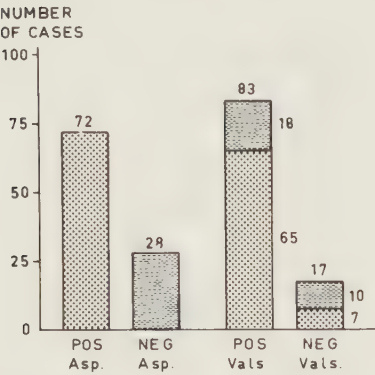


Fig. 4. The grouping of the material according to aspiration-deflation test and tubal patency.

MATERIAL

The material consisted of 100 patients (100 ears) with a central perforation following chronic otitis media, and operated on consecutively between 1974 and 1976. There were 47 women and 53 men. The age distribution is given in Table I. 75 patients underwent simple myringoplasty; the remaining 25, myringoplasty combined with ossiculoplasty. The take rate and hearing gain refer to the re-examination one year after the operations. The investigation in the pressure chamber was performed between 1 and 3 years after the operation.

RESULTS

Preoperatively, Politzer's test was positive in all cases. Valsalva's manoeuvre was positive

Table III. Percentual distribution of 68 healed myringoplasties in different air-bone gap groups pre- and postoperatively related to the aspiration capacity

Air-bone gap (dB)	Pos. aspir. (47)		Neg. aspir. (21)	
	Preop. (%)	Postop. (%)	Preop. (%)	Postop. (%)
0-10	6	73	10	76
11-20	32	20	47	19
20-	62	7	43	5

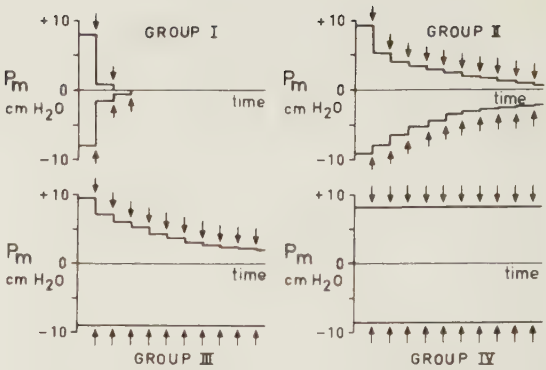


Fig. 5. Tubal function groups according to the aspiration-deflation method.

in 83% and Toynbee's test in only 37%. The aspiration test was positive in 72% (Fig. 4). Use was made of the grouping according to Elner et al. (1971b) (Fig. 5), who divided their material of normal ears into four tubal function groups. In our investigation, groups I and II were merged into the positive aspiration group and groups III and IV into the negative. The maximum residual pressure tolerated in the positive group was -9 cmH₂O.

The total take rate was 89% and there was no difference between cases operated on with myringoplasty, 90% (68/75), or myringoplasty + ossiculoplasty, 84% (21/25) (*p*>0.05). The healing results showed no correlation to the preoperative aspiration capacity or to Valsalva's manoeuvre (Table II). The volume was measured on 86 ears in the preoperative investigation and the mean volume was 3.15±0.28 ml. Of these, 76 healed with a preoperative mean volume value of 3.23±0.30 and the remaining 10 with a mean volume of 2.48±0.59

Table IV. Aspiration capacity pre- and postoperatively after successful myringoplasty (50 ears)

Aspiration capacity	Preop.	Postop.
Positive	34	45
Negative	16	5

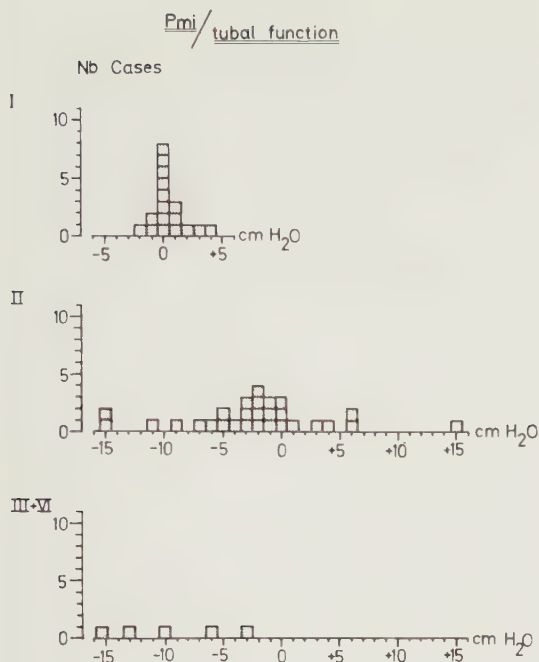


Fig. 6. Initial middle ear pressures (P_{mi}) in relation to tubal function groups.

ml did not heal. There is no statistically significant difference between the mean volume values in the healed and the non-healed groups ($p > 0.05$).

Since technical failures in the ossiculoplasty group could affect the hearing results, only the hearing gain in the myringoplasty group is presented (Table III). The results are presented as the percentage distribution of patients in different air-bone gap groups, 0–10, 11–20 and 20– dB pre- and postoperatively and related to aspiration capacity. No significant statistical difference in hearing gain between the two tubal function groups was found ($p > 0.05$).

Out of the 100 ears in the material, 59 (50 with intact ear drums and 9 with perforations) were retested with the pressure chamber technique. The pre- and postoperative findings are compared in Table IV. Obviously the tubal function improves after successful surgery. Of 34 ears with a positive preoperative aspiration capacity, only two turned negative, while 13 out of 16 patients with a preoperative negative capacity turned positive postoperatively.

As for the 9 ears with persistent perforations or reperforations, the figures were somewhat different (Table V). Two ears with preoperative good function got worse and lost aspiration capacity. Only one from the negative group showed a positive aspiration capacity. Valsalva's test was positive in 80% (40/50) postoperatively.

Fig. 6 shows the initial middle ear pressures in relation to the tubal function groups according to Elner et al. (1971c). In group I with a perfect aspiration capacity the initial middle ear pressures were zero or virtually zero. In group II with slightly impaired aspiration capacity the values varied widely, but with a tendency towards negative middle ear pressures. In groups III and IV without aspiration capacity the initial middle ear pressures were invariably negative. These 5 patients, however, were capable of inflating their ears with the aid of Valsalva's manoeuvre.

The compliance curves showed a variety of findings. Mostly they were very flat, and no definitive patterns in relation to the tubal function could be recognized.

Finally "the sniff test" was performed in 32 cases. Six of those could create an underpressure in the middle ear with this technique.

DISCUSSION

As stated earlier (Andreasson & Ivarsson, 1976) Politzer's and Valsalva's tests are patency tests. Politzer's test was positive in all cases, but this only means that there is no organic stenosis of the Eustachian tube. Ability to perform a positive Valsalva manoeuvre

Table V. Aspiration capacity pre- and postoperatively in drums with a perforation postoperatively (9 ears)

Aspiration capacity	Preop.	Postop.
Positive	7	6
Negative	2	3

is probably favourable for the postoperative aeration of the middle ear. To some degree this depends on training factors. As expected, there was no change in the ability to perform Valsalva's manoeuvre in the postoperative investigation. Nor is there any correlation between aspiration capacity and tubal patency as tested with Valsalva's manoeuvre the other comprising. (Fig. 5).

As far as we know the aspiration test best reflects the normal physiological function of the Eustachian tube. Two major objections can be raised, however. One is that the test period is only 2–3 minutes, which means that we are unaware of any possible fluctuations in the function during a longer period of time. The other is that some individuals regularly equilibrate the underpressure created in their middle ears by other ways than swallowing, i.e. by yawning, by moving their jaws or even by autoinflation. The test methods must therefore be further developed and refined.

The positive finding in this study is the definitive improvement of the tubal function in healed ears. In their investigation Siedentop et al. (1968) found a tendency to improvement, which they attributed to the surgical procedure, i.e. removal of granulations and polyps at the tubal orifice of the middle ear. In our material, however, no such lesions were seen in the 13 ears transferred from the negative to the positive aspiration group (Table IV). The most probable explanation for this is some change in the middle ear mucosa. Since the volume of the mucosal lining is highly dependent on the blood filling, a change could be explained by the altered environment in the closed middle ear. Another explanation might be that in ears with perforated drums there is no pressure difference across the Eustachian tube, but when the ear is closed a more physiological situation occurs with repeatedly created underpressures, which might function as a possible trigger mechanism inducing the tube to start functioning.

In our study the preoperative volume did not influence the outcome of the operation.

This is not in accordance with Holmquist's & Bergström's (1978) findings. In order to obtain a better comparison between the materials we divided ours into two groups, one with a negative aspiration capacity and a volume value below 3 ml (17 ears), and the other comprising the rest of the material in which the volume was measured (69 ears). A volume value of 3 ml corresponds to an area on the X-ray of about 9 cm² (Andreasson, 1976) which is a critical value according to Holmquist & Bergström. The healing results in the first group were 87% (15/17) and in the rest of the material, 87% (60/69) which does not mean any significant difference ($p > 0.05$).

According to recent findings by Ekvall & Magnusson (1977) the "sniffing habits" of the patient might be an important pathophysiological factor in middle ear disease. In our postoperative study, 6 out of 32 (19%) could propagate a negative rhinopharynx pressure to their middle ears. We believe that this mechanism might only in some cases contribute to the problems in middle ear pathology.

The tubal function tests now in use as well as the volume determination of the air-filled ear spaces seem to be of no value for selecting patients suitable for middle ear surgery. The postoperative improvement of the tubal function in healed ears indicates that an impaired tubal function is probably secondary to other factors responsible for the development of chronic otitis media. We feel that continued research on the pathophysiological mechanisms in chronic otitis media is called for.

REFERENCES

- Andreasson, L. 1976. Correlation of tubal function and volume of mastoid and middle ear space as related to otitis media. *Ann Otol* 85, 198.
- Andreasson, L. & Ivarsson, A. 1976. On tubal function in presence of central perforation of the drum in chronic otitis media. *Acta Otolaryngol* (Stockh) 82, 1.
- Ekvall, L. 1970. Eustachian tube function in tympanoplasty. *Acta Otolaryngol* (Stockh), Suppl. 263, 33.
- Ekvall, L. & Magnusson, B. 1977. Reverse aspiratory middle ear disease. A neglected pathogenic principle. Lecture at XIth World Congress on Otolaryngology.
- Elner, Å., Ingelstedt, S. & Ivarsson, A. 1971a. A method

- for studies of the middle ear mechanics. *Acta Otolaryngol* (Stockh) 72, 191.
- 1971*b*. The normal function of the Eustachian tube. *Acta Otolaryngol* (Stockh) 72, 320.
- 1971*c*. Indirect determination of the middle ear pressure. *Acta Otolaryngol* (Stockh) 72, 255.
- Flisberg, K., Ingelstedt, S. & Örtengren, U. 1963. Controlled ear aspiration of air. *Acta Otolaryngol* (Stockh), Suppl. 182, 235.
- Holmquist, J. 1968. The role of Eustachian tube in myringoplasty. *Acta Otolaryngol* (Stockh) 66, 289.
- Holmquist, J. & Bergström, B. 1978. The mastoid air cell system in ear surgery. *Arch Otolaryngol* 104, 127.
- Lee, K. & Schuknecht, H. F. 1971. Results of tympanoplasty and mastoidectomy at the Massachusetts Eye and Ear Infirmary. *Laryngoscope* 81, 529.
- Miller, G. F., Jr & Bilodeau, R. 1963. Preoperative evaluation of Eustachian tube function in tympanoplasty. *South Med J* 60, 868.
- Siedentop, K. H., Tardy, M. E. & Hamilton, L. R. 1968. Eustachian tube function. *Arch Otolaryngol* 88, 386.
- Siedentop, K. H., Hamilton, L. R. & Osenar, S. B. 1972. Predictability of tympanoplasty results. *Arch Otolaryngol* 95, 146.
- Virtanen, H. 1977. Eustachian tube sound conduction. Diss. Meder-offset espoo, Helsinki.

Lars Andreasson
ENT-department
Malmö General Hospital
S-214 01 Malmö
Sweden

PREOPERATIVE ROENTGEN EXAMINATION IN EAR SURGERY

S. Harris¹ and P. Lörinc²

*From the ¹ENT Department and the ²Radiological Department, University of Lund,
Malmö General Hospital, Malmö, Sweden*

(Received January 30, 1980)

Abstract. 680 patients with various ear diseases were examined preoperatively with a simultaneous multisectonal tomography technique originally proposed by McGann. This method is technically easier and quicker than Polytome simple section tomography. In 83% the roentgenological and surgical findings were in agreement. This, together with analysis of the causes of the discrepancies between the corresponding findings in the remaining 17%, appeared to warrant the following indications for preoperative roentgenological examination in ear surgery: *obligatory* in tumours, congenital abnormalities, fractures, foreign bodies and infectious complications; *facultative* in chronic otitis media with cholesteatoma and in revision/reconstruction of radical cavities; *questionable* in uncomplicated chronic otitis media and ossicular fixations/deficiencies.

Radiography of the temporal bone was initially used in the examination of the mastoid process for bone destruction and coalescence of cells, i.e. evidence of acute suppurative mastoiditis indicating operation. Thus, in his roentgenologic study of acute and chronic otitis media, Runström (1933) proposed certain projections which have since been used routinely at laboratories in Sweden (Diamant, 1940; Welin, 1941). But the development of reconstructive surgery of the ear in chronic otitis media and congenital anomalies as well as in the surgery of fractures and tumours of the temporal bone required better visualization of the lesions.

This requirement was met by the development of tomography. Although Ziedses des Plantes had described the principle of this new technique already in 1932, it was not until 1950, when Sans and Porcher presented their Polytome that the new era in ear roentgeno-

logy began. Many authors (Frey, 1956; Jensen & Røvsing, 1971; Valvassori & Buckingham, 1975) have since demonstrated the high degree of accuracy of images obtained by thin-layer tomography with multidirectional blurring with the aid of a Polytome device. However, the Polytome technique has two serious drawbacks, viz. purchase costs of the equipment are high and the procedure is time-consuming. These have restricted the use of the method to a few central departments.

Moreover, the value of X-ray investigations before ear surgery has been questioned (Smyth et al., 1971; Austin, 1972) and many surgeons now lack clear-cut guide lines for preoperative roentgenologic examinations.

The present paper concerns the reliability of a less widely known simultaneous multisection tomographic technique utilizing a Siemens Multiplanigraph apparatus and indications for preoperative roentgenologic examination in modern ear surgery.

MATERIAL

The material consisted of 680 (287 females, 393 males) patients subjected to preoperative tomography of the ear on altogether 705 occasions over a 10-year period, 1969-78. 24 patients were operated upon twice; 10 of them bilaterally after one X-ray examination and 3 after two; in 10 the same ear was re-operated upon after a second examination, and one was operated upon twice on one side and once on

Table I. Age distribution of the material at the time of roentgen examination

Age (years)	No. of patients
0-10	46
11-20	55
21-30	127
31-40	109
41-50	129
51-60	150
61-70	57
71-80	7
Total	680

the other after roentgenologic examination on altogether three occasions.

The mean age of the patients at the time of the roentgen examination was 39 years (range 8 months to 78 years). The age distribution is given in Table I. The interval between roentgen examination and surgery ranged from less than 1 day to 86 months (mean 9 months). Patients with mastoiditis and foreign bodies were, of course, operated upon immediately. The interval was longest for patients with ossicular defects. The peroperative diagnosis

Table II. Operative diagnosis

For figures marked with an asterisk, see text

Chronic otitis media	344
Chronic otitis media with cholesteatoma	202
Radical cavity	53
Otosclerosis	33*
Mastoiditis	8
Cancer in external ear canal	8
Ossicular defects	7*
Atresia in the ear canal/middle ear	7
Luxation of incus	7
Fixation of stapes	5*
Radical cavity with cholesteatoma	4
Exostosis in outer ear canal	4
Foreign body in middle ear	4
Sudden deafness	3
Acoustic neurinoma	3
Incus missing after mastoidectomy	2
Facial paralysis	2
Chronic otitis media with facial paralysis	2
Fixation of lateral ossicular chain	1*
Vertigo	1
Osteopetrosis	1*
Cholesteatoma of the outer ear canal	1
Benign tumour of the outer ear canal	1
Facial spasm	1
Fractures in skull base and ear	1
Total	705

Table III. Operation

Myringoplasty	164
Combined approach tympanoplasty (CAT)	152
Tympanoplasty	124
Radical mastoidectomy	98
Reconstruction of radical cavity	47
Stapedectomy	35
Ossiculoplasty	17
Mastoidectomy	16
Op. for cancer in external ear canal	8
Tympanotomy	8
Revision of radical mastoidectomy	7
Operation for atresia in ear canal/middle ear	7
Tympanotomy, alienation and myringoplasty	4
Op. for exostosis in outer ear canal	4
Exploration of the facial nerve	3
Suboccipital op. of acoustic neurinoma	3
Radical mastoidectomy and reconstruction	2
Stapes mobilization	1
Op. for benign tumour in outer ear canal	1
Labyrinthectomy	1
Stapedectomy and ossiculoplasty	1
Exploration of middle fossa and tympanoplasty	1
Op. for cholesteatoma in outer ear canal	1
Total	705

and the operations performed are given in Tables II and III.

METHODS

All the patients were examined with the simultaneous plesio-sectional tomography tech-

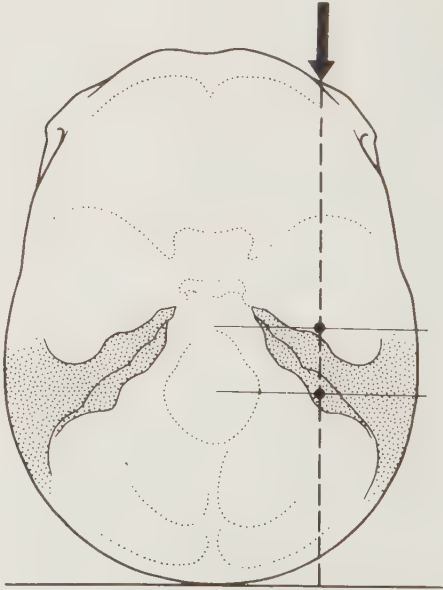


Fig. 1. Schematic drawing of the anteroposterior projection according to Mündnich & Frey (1959).



Fig. 2. One of four simultaneous multisectional tomographic films (anteroposterior projection). A foreign body (1 mm welding spark) is visualized in the right ear.

nique described by McGann (1962). A multi-sectional cassette 24×30 cm with four pairs of matched intensifying screens was used, which means that four films were exposed simultaneously. This cassette was divided into four fields, which were exposed one after another with appropriate positioning of the cassette in the Bucky tray and with varied intervening distance to the X-ray tube. Since the distance between the consecutive films was 1 mm, the most important parts of the temporal bone

could be demonstrated by four ($4 \times 4 = 16$ mm) exposures in the anteroposterior view (which was always used) (Figs. 1 and 2). Using this projection, both ears could be examined simultaneously.

In 183 (27%) of the patients the lateral projection was also used. Six or twelve exposures, depending on the diagnosis, were used for the affected ear. The tomographic equipment consisted of a Siemens Multiplanigraph with a Biangulix Rapid 125/30/50 R tube. The

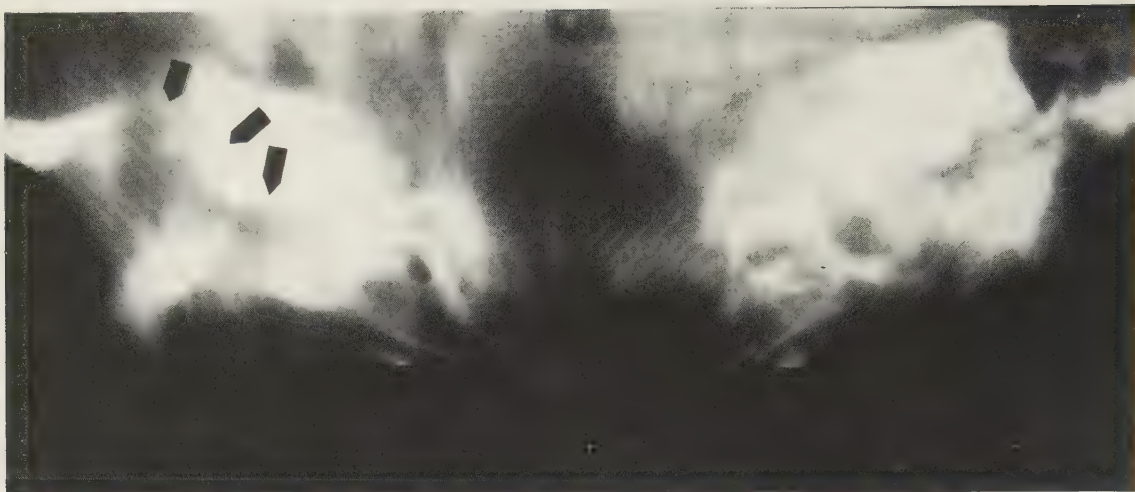


Fig. 3. Squamous cell carcinoma of the external ear canal with propagation into the middle and inner ear.

fine focus of the tube with a focus spot size of 0.6 mm was always used. The blurring was performed with an elliptical movement. In all examinations the following conventional roentgenograms were also obtained:

- 1) axial
- 2) anteroposterior
- 3) lateral (projection II according to Runström, also called the B-ear)
- 4) lateral (projection II with a further angulation of 6° to obtain a stereoscopic view)
- 5) projection III according to Runström (also called the C-ear or Stenvers projection)
- 6) Chausse III (Chausse, 1950)

The findings in the roentgenograms were successively compared with the operative findings and in cases with discrepancies the films were re-examined and the causes explained.

RESULTS AND COMMENTS

After comparison between the roentgenologic and surgical findings the material could be divided into two major groups (Table IV).

A. Accordant findings

In 587 (83.3%) out of 705 examinations surgery confirmed the tomographic demon-

stration. Sufficient reliable information was obtained by tumours (Fig. 3), congenital abnormalities, fractures (Fig. 4), foreign bodies (Fig. 2), infectious complications and most cholesteatomas (Fig. 5).

B. Discordant findings

This group of 118 (16.7%) examinations could be further divided into four subgroups (Table IV).

I. *Misinterpretations.* In 34 (4.8%) cases the review revealed that the films had been falsely interpreted the first time, errors that could be attributed to the "human factor"; tomographic changes had been missed in 29 and the diagnosis had been false-positive in 5. In no case, however, had these errors had any untoward consequences.

II. *Technical faults.* In 12 (1.7%) cases the films were of poor quality and should not have been accepted. The poor quality was due mainly to inaccuracy in exposure timing and to inaccurately centered projections.

III. *Bone lesions too small to be detected.* In the 47 (6.7%) cases marked with an asterisk in Table II the lesions, i.e. mainly otosclerotic foci and minor defects in the ossicles, could not be visualized. These patients were dealt with early in the series before we became



Fig. 4. Fracture through the inner ear.

aware of the limitations of the tomographic technique used.

IV. *Uncertain causes.* The remaining 25 (3.5%) cases are given in Table V according to the diagnosis and the type of discrepancy found.

DISCUSSION

The group of uncertain causes of the discrepancies probably reflects the diagnostic limitations of the method. A more detailed analysis of this group might therefore not be out of place. Group IV would probably have been smaller if lateral projections had been included in all the examinations, especially in patients 5, 8, 13, 14, 17, 20, 23, 24 and 25 in Table V. In 3 cases of cholesteatoma the interval between tomography and operation was probably responsible for the discrepancy (pa-

tients 8, 13 and 14 in Table V). The difficulty in detecting defects in the facial bony covering in the middle ear might be due in part to the fact that the projections used are not ideal for this specific diagnosis (Wilbrand, 1974) and partly to the fact that opacities caused by cholesteatoma or granulation tissue are less well defined and thereby apt to conceal the defects. In this context it should be pointed out that a varying degree of dehiscence of the tympanic portion of the facial canal is normal in probably at least 15% of the general population (Banfai, 1976).

In 11 cases the tomograms showed no evidence of an existing cholesteatoma. This means that preoperative diagnosis was correct in 196 (95%) out of 207 cases. In the group of chronic otitis media with cholesteatoma (Table II) 15 ears had been subjected to ear surgery before. Eight of the cholesteatomas

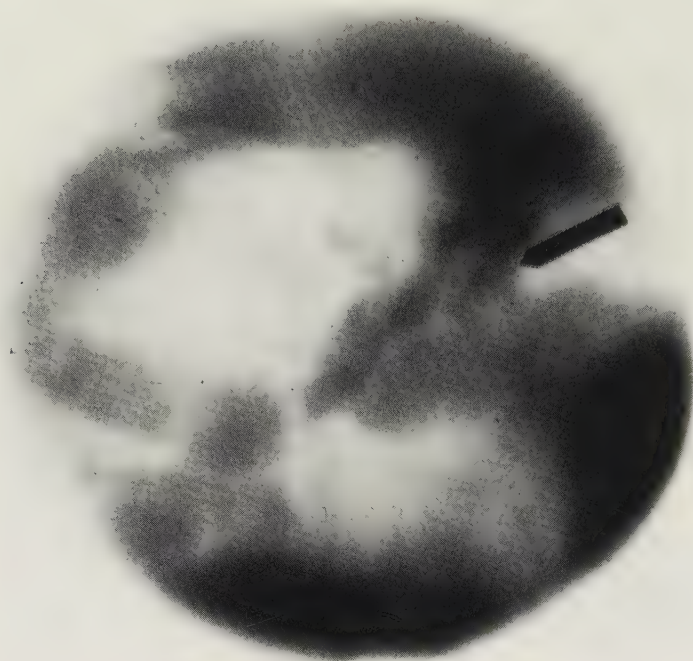


Fig. 5. Typical destructions caused by cholesteatoma.

missed were in ears that had been operated on earlier (Table V), which means that the diagnosis was correct in 184 (98%) out of 187 patients not previously subjected to ear operation. These figures are comparable to those reported in other materials where the Polytome tomography technique had been used. Brünner et al. (1966), Brahe-Pedersen & Brünner (1970) and Schreyer et al. (1975) give figures ranging from 90 to 95%. Like them, we can assume that bony destruction, especially of the superior and posterior medial margins of the external bony canal (the scutum or the spur) and the aditus and antrum areas, is very probably evidence of a cholesteatoma (Fig. 5). On the other hand, early cholesteatomas produce only soft tissue changes, and are therefore apt to remain concealed (Hanafée et al., 1974), as they were in two of our three missed cases of

cholesteatomas in ears not previously operated upon.

In our material even huge cholesteatomas developed in the preformed cavities after earlier operations without being roentgenologically detected (patients 5, 8, 10, 12, Table V). Compere's (1972) opinion that radiographic follow-up after cholesteatoma surgery with the closed technique is important must therefore be challenged. Summing up, tomography is a valuable method for detecting, but not for excluding, cholesteatomatous disease.

Two minor luxations of the incus were missed, but never the absence of an ossicle or major luxations. Therefore the postulation by some authors (du Boulay & Bostick, 1969) that linear tomography gives results comparable to those obtainable with Polytome tomography with hypocycloid blurring must be

Table IV. *Comparison between surgical and roentgenological findings in 705 ears investigated with simultaneous multisection tomography*

Group	No.	%
A. Accordant findings	587	83.3
B. Discordant findings		
I. Misinterpretations	34	4.8
II. Technical faults	12	1.7
III. Bone lesions too small to be detected	47	6.7
IV. Uncertain causes	25	3.5
	705	100

questioned when it comes to the tiny structures of the middle ear. Moreover, the physical limits of the value of the simultaneous tomography were defined by Gajewski & Liese as far back as 1955. The advantage of the Polytome tomography technique is thus its better resolving power. The advantage of the simultaneous multisectional tomography technique is not only that the examination costs are lower but also that it is less time-consuming. The time required is only about one fourth of that for Polytome tomography. This in turn means that it is easier to keep the patient immobile, which is a prerequisite for a good roentgenogram. The anteroposterior projection depicts both sides in a single film which facilitates orientation and comparison of the two ears. If the preoperatively suspected diseases assigned to group III are excluded we can expect a take-rate of almost 90 % with the simultaneous multisectional tomography. Under optimal conditions, i.e. no false interpretations (group I) and no qualitatively poor roentgenograms (group II) this figure will rise to 96 %.

The radiation dose to which the patient is exposed must always be borne in mind. Some feel that simultaneous multisectional tomography gives less radiation than Polytome single section tomography (Gajewski & Liese, 1955; Balevich & Kitaev, 1972), but no systematic investigation of this point is available.

Apart from the tomography we routinely used six conventional roentgenograms. This is not absolutely necessary, but one or two general views are indispensable. The choice of such projections depends on the specific diagnostic problem.

From a surgical point of view it is, of course, interesting to find out how valuable the roentgen examination is for the surgeon. Judging from our experience, the indications for preoperative roentgenography can be graded according to Table VI.

Obligatory indications

1. *Tumours.* In the treatment of aggressive squamous cell carcinomas originating from the external ear canal preoperative knowledge of the extent of bony involvement is of the utmost importance when planning the surgical approach (Fig. 3). Enlargement of the inner ear canal in acoustic neurinoma was well demonstrated in all our 3 cases. The value of the method in this respect has also been shown by Lapayowker et al. (1962). Further roentgen analysis is, of course, advisable in these cases (Lilja, 1939). Encephalography with air or cisternography with positive contrast has hitherto been the usual procedure (Thomsen et al., 1976) but also computer tomography has proved to be very informative (Davis et al., 1977; Möller et al., 1978). In the investigation of vascular tumours, i.e. glomus tumours, angiography and sometimes jugulography (Gejrot & Linbom, 1960) are recommended.

2. *Congenital abnormalities.* For evaluation of the prospects and type of reconstructive surgery, roentgenology is indispensable. Of special interest are the anatomical relationships between the middle ear cleft and the mandibular joint, the pneumatization of the mastoid and the position of the facial canal. Thorough tomographic investigations in this field with the Polytome technique have been presented by Terrahe (1972) and Phelps et al. (1977).

3. *Fractures.* A careful preoperative ana-

Table V. *Diagnosis and non-visualized lesions in the group with uncertain cause of discordance between roentgenological and operative findings*

Patient	Age (years)	Perop. diagn.	Earlier op. on affected ear	Interval, X-ray-op.	Lateral tomogr.	Non-visualized lesions	
						Cholesteatoma	Dural expos.
1. W. A.	44	Chron. otitis m. + cholesteat.	—	5 mo.			
2. T. A.	26	Chron. otitis m. + cholesteat.	—	5 mo.	×		×
3. D. B.	43	Chron. otitis m. + cholesteat.	—	3 mo.			
4. G. E.	45	Chron. otitis m. + cholesteat.	—	3 days		×	
5. M. F.	15	Chron. otitis m. + cholesteat.	Mastoidect.	3 mo.		×	
6. S. H.	60	Chron. otitis m. + cholesteat.	—	2 mo.			
7. K. H.	23	Chron. otitis m. + cholesteat.	—	2 mo.			
8. H. H.	12	Chron. otitis m. + cholesteat.	Mastoidect.	42 mo.		×	
9. K. J.	26	Chron. otitis m. + cholesteat.	—	2 days			×
10. D. J.	9	Chron. otitis m. + cholesteat.	Antrotomy	7 days		×	
11. L. L.	61	Chron. otitis m. + cholesteat.	Mastoidect.	1 day			
12. G. M.	63	Chron. otitis m. + cholesteat.	Mastoidect.	1 mo.	×	×	
13. H. M.	28	Chron. otitis m. + cholesteat.	—	9 mo.			×
14. K. N.	26	Chron. otitis m. + cholesteat.	—	16 mo.			×
15. J. O.	6	Chron. otitis m. + cholesteat.	—	5 mo.		×	
16. S. T.	34	Chron. otitis m. + cholesteat.	—	5 mo.		×	
17. B. K.	33	Radical cavity + cholesteat.	Radical mastoidect.	2 mo.		×	×
18. S. O.	15	Radical cavity + cholesteat.	Radical mastoidect.	3 mo.		×	
19. H. P.	20	Radical cavity + cholesteat.	Radical mastoidect.	2 mo.	×	×	
20. S. W.	33	Radical cavity + cholesteat.	Radical mastoidect.	2 mo.		×	
21. M. A.	45	Radical cavity	Radical mastoidect.	15 mo.	×		×
22. L. A.	32	Radical cavity	Radical mastoidect.	60 mo.			×
23. J. H.	29	Radical cavity	Radical mastoidect.	37 mo.			×
24. S. B.	47	Luxation of incus	Mastoidect.	18 mo.			
25. R. N.	23	Luxation of incus	—	13 mo.			
					4	11	8

Table VI. Indications for preoperative roentgenology

Facial nerve exposed in middle ear	Luxation of incus	Lateral semicircular canal fistula	Lat. sinus exposed
×			
×			
×		×	
×			
×		×	
			×
×			
	×		
	×		
6	2	2	1

Obligatory

Tumours
Congenital abnormalities
Fractures
Foreign bodies
Infectious complications

Facultative

Chronic otitis media with cholesteatoma
Radical cavities subjected to revision/reconstruction

Questionable

Chronic otitis media without complications
Ossicular fixation/deficiencies

lysis is imperative in the management of all traumatic injuries (Fig. 4). Preoperative investigations might be recommended also for medico-legal reasons.

4. *Foreign bodies*. Localization of metallic foreign bodies in the middle ear is an obvious indication. In Sweden ear damage caused by welding sparks is not uncommon (Fig. 2) (Andréasson & Elner, 1974).

5. *Infectious complications*. In our series there were 8 cases of mastoiditis, including two roentgenologically visible perisinuous abscesses. In more serious complications, such as brain abscesses, preoperative preparation without roentgenology is hazardous.

Facultative indications

1. *Chronic otitis media with cholesteatoma*. It is mainly in this group that the indications for roentgenology have been questioned. Experienced surgeons, such as Smyth (1971) and Austin (1972), consider it "a waste of money and time". But, like Parker (1974), we feel that most surgeons are better prepared to perform an operation if they are informed about the extent of the cellular system and the positions of the lateral sinus and dural plate.

2. *Radical cavities subjected to revision/reconstruction*. Also in these cases the indication is mainly to avoid unpleasant surprises, such as large defects in the bony covering of the dura, lateral sinus and facial nerve.

Questionable indications

1. *Chronic otitis media without complications.* Since most tympanoplastic procedures are performed via a transcanal approach, careful microscopic investigation is, as a rule, more informative than the most perfect ear tomography.

2. *Ossicular fixation/deficiency.* Anamnestic data together with the audiologic analysis including impedance measurements can usually give the surgeon a good idea of the actual ossicular disorder. Moreover, most ear surgeons are nowadays well able to deal with various ossicular disorders and can, for instance, change their mind during the operation and decide on stapedectomy instead of the planned reconstruction of the lateral chain, or vice versa.

Had the indications proposed above been applied in the present material, the indications for roentgen examinations would have been obligatory in only 30 (4.3%) cases. In 37.0% they would have been facultative, while in 58.7% the indications would have been questionable.

In view of the above figures, it might be argued that preoperative roentgenography is so often unnecessary that it should be restricted to cases in which the indication is obligatory, but it must be questioned whether such a policy would be wise. For it would mean that the surgeon might somehow be deprived of valuable preoperative knowledge and, what is still more important, it would jeopardize the possibility of the roentgenologist's getting sufficient training to maintain an adequate standard of roentgenology of the ear.

ZUSAMMENFASSUNG

680 Patienten mit verschiedenen Ohrenkrankheiten wurden mit einer ursprünglich von McGann vorgeschlagenen „multiscreen“-Methode vor der Operation tomografisch geröntgt. Diese Methode unterscheidet sich vorteilhaft von der Einzelschichtverfahren mit Polytome, indem sie einfacher in der Handhabung und weniger zeitraubend ist. In 83 Prozent der Fälle bestand eine gute Übereinstimmung zwischen den röntgenologischen und operativen Befunden. Die Anlässe zu unterschiedlichen Befunden sind

untersucht worden. Auf Grund dieser Untersuchungen werden folgende Indikationen zur röntgenologischen Untersuchung vor chirurgischen Eingriffen am Ohr vorgeschlagen: 1) *Absolute Indikationen:* Tumoren, angeborene Mißbildungen, Frakturen, Fremdkörper, entzündliche Komplikationen. 2) *Relative Indikationen:* chronische Mittelohrentzündung mit Cholesteatom, Radikalhöhlen bei beabsichtigter Revision oder Rekonstruktion. 3) *Zweifelhafte Indikationen:* Chronische Mittelohrentzündung ohne Komplikation, Gehörknöchelfixationen bzw. -schwund.

REFERENCES

- Andréasson, L. & Elner, Å. 1974. Svetsning och öronskador. *Läkartidningen* 71, 2553.
- Austin, D. 1972. Transcanal tympanoplasty. *Otol Clin N Amer* 5, no. 1, 127.
- Balevich, O. & Kitaev, V. 1972. Thinlayer simultaneous tomography of the pyramids of the temporal bones. *Vestnik Otorinolaringol* 34, 64.
- Banfai, P. 1976. Die angewandte Klinische Anatomie des Nervus facialis. *HNO* 24, 253.
- du Boulay, G. & Bostick, T. 1969. Linear tomography in congenital abnormalities of the ear. *Br J Radiol* 42, 161.
- Brahe-Pedersen, C. & Brünner, S. 1970. Tomographic examination of cholesteatomas in the middle ear. *Acta Otolaryngol* (Stockh) 70, 167.
- Brünner, S., Petersen, Ö. & Sandberg, L. 1966. Tomography in cholesteatoma of temporal bone. *Am J Roentgenol* 97, 588.
- Brünner, S. & Sandberg, L. 1970. Tomography in cholesteatoma. *Arch Otolaryng* 91, 560.
- Buckingham, R. & Valvassori, G. 1967. Correlation of surgical and tomographic findings in cholesteatoma of middle ear and mastoid. *Trans Am Acad Ophthalmol Otolaryngol* 77, 673.
- Chausse, G. 1950. Trois incidences pour l'examen du Rocher. *Acta Radiol* 34, 274.
- Compere, W. Jr. 1972. *Otitis Media* (ed. A. Glorig & K. Gervin), pp. 20, 185. C. C. Thomas, Springfield, Ill.
- Davis, K., Parker, S., New, P., Roberson, G., Taveras, J., Ojemann, R. & Weiss, A. 1977. Computed tomography of acoustic neuroma. *Radiology* 124, 81.
- Diamant, M. 1940. Otitis and pneumatisation of the mastoid bone. *Acta Otolaryngol* (Stockh), Suppl. 41.
- Frey, K. W. 1956. Schichtaufnahmen des Felsenbeines mit polyzyklischer Verwischung. *Fortschr Röntgenstr* 85, 433.
- Gajewski, H. & Liese, E. 1955. Das Simultan-Schichtverfahren. Aufnahmetechnische Grundlagen und medizinische Anwendung. *Fortschr Röntgenstr* 83, 562.
- Gejrot, T. & Lindbom, A. 1960. Venography of the internal jugular vein and transverse sinuses—retrograde jugulography. *Acta Otolaryngol* (Stockh) 52, 180.
- Hanafee, W., Aquilar, G. & Olmsted, W. 1974. Pitfalls of soft tissue diagnosis in the tympanic cavity. *Am J Roentgenol* 122, 598.
- Jensen, J. & Røvsing, H. 1971. *Fundamentals of Ear Tomography*. C. C. Thomas, Springfield, Ill.

- Lapayowker, M., Carter, B. & McGann, M. 1962. The use of plesiosectional tomography in the diagnosis of eighth nerve tumours. *Am J Roentgenol* 88, 1187.
- Lilja, B. 1939. Displacement of the calcified Pineal body in roentgen pictures as an aid in diagnosing intracranial tumours. *Acta Radiol*, Suppl. XXXVII.
- McGann, M. 1962. Plesiosectional tomography of the temporal bone. A new multiscreen cassette. *Am J Roentgenol* 88, 1183.
- Mündnich, K. & Frey, K. W. 1959. *Das Röntgenschnittbild des Ohres*. Thieme, Stuttgart.
- Möller, A., Hatam, A. & Olivecrona, H. 1978. Diagnosis of acoustic neuroma with computed tomography. *Neuroradiol* 17, 25.
- Parker, R. 1974. Routine radiography in early cholesteatomatous middle ear disease. *J Laryngol Otol* 89, 151.
- Phelps, P., Lloyd, G. & Sheldon, P. 1977. Congenital deformities of the middle and external ear. *Br J Radiol* 50, 714.
- Runström, G. 1933. A roentgenological study of acute and chronic otitis media. *Acta Radiol*, Suppl. XVII.
- Sans & Porcher. 1950. Polytome. *J Radiol Electrol Med Nucl* 31, 300.
- Schertel, L., Scholz, M. & Kraska, H. 1974. Schläfenbeintomographie. *Fortschr Röntgenstr* 121, 556.
- Schreyer, H., Zechner, G. & Sager, W. D. 1975. Die Röntgendiagnostik chronischer entzündlicher Erkrankungen des Mittelohres mittels Tomographie. *Röfo* 123, 144.
- Smyth, G., Kerr, A. & Goodey, R. 1971. Current thoughts on combined approach tympanoplasty. *J Laryngol Otol* 85, 205.
- Terrahe, K. 1972. Diagnostik der Missbildungen des Ohres und des Ohr-Schädels. *Arch Klin Exp Ohren Nasen Kehlkopfheilk* 202, 85.
- Thomsen, J., Lester, J. & Zilstorff, K. 1976. Cerebello-pontine pantopaque cisternography and tomography of the internal acoustic meatus in the diagnosis of angle tumours. *Arch Oto-Rhino-Laryngol* 214, 157.
- Valvassori, G. & Buckingham, R. 1975. *Tomography and cross sections of the ear*. Thieme, Stuttgart.
- Welin, S. 1941. Beiträge zur Röntgendiagnostik der Otitis media acuta und ihrer Komplikationen im Schläfenbein. *Acta Radiol*, Suppl. XLII.
- Wilbrand, H. 1974. Multidirectional tomography of minor detail in the temporal bone. *Acta Univers Upsaliensis* 187.
- Ziedses des Plantes, B. 1932. A new method of differentiation in roentgenography (planigraphy). *Acta Radiol* 13, 182.

Sten Harris, M.D.
Dept. of Otolaryngology
Malmö General Hospital
S-214 01 Malmö
Sweden

PREOPERATIVE TEST OF BLEEDING TIME IN EAR SURGERY*

S. Harris¹ and I. M. Nilsson²

From the ¹ENT Department and ²Coagulation Laboratory, University of Lund, Malmö General Hospital, Malmö, Sweden

(Received June 26, 1979)

Abstract. In 300 patients subjected to ear surgery the bleeding time according to Ivy was determined preoperatively. In 25 cases prolonged bleeding time was found. Further investigations revealed mild thrombosthenia in 4 cases and enhanced fibrinolytic activity in one instance. In 10 patients the cause was intake of drugs containing acetylsalicylic acid. During operation the patients were treated with AMCA and in two cases fresh blood also was given. Even slightly enhanced bleeding can affect the results in microsurgery of the ear. We therefore suggest that bleeding time should be determined as a preoperative routine in order to detect the patients in need of specific treatment. Patients also should be recommended to avoid drugs containing acetylsalicylic acid for a fortnight before surgery.

Good control of the bleeding in the operating field is a pre-requisite nowadays for successful microsurgery of the ear. The usual ways to achieve this condition are careful local hemostasis, various forms of low-pressure anesthesia and locally administered adrenalin. In spite of these precautions some patients present bleeding problems. In order to find this group preoperatively we sought a screening procedure for the detection of disorders of hemostasis, e.g. conditions with defective platelet function, decreased factor VIII related antigen levels and high fibrinolytic activity. The test of choice seemed to be determination of the bleeding time *ad modum* Ivy. The aim of this investigation was three-fold, viz. (1) to detect patients with prolonged bleeding time preoperatively, (2) to elucidate the actual disorder, and (3) to find the specific treatment during surgery.

MATERIAL

The material consisted of two series of altogether 300 patients operated on for various

diseases in the middle ear and air cell system. The first 100 patients were subjected to operative procedures which were planned to exceed 2 hours, e.g. mainly cholesteatoma surgery and reconstructive surgery in radical mastoidectomy cavities. In the second series, comprising 200 cases, all patients subjected to ear surgery were consecutively investigated. This means a predominance of stapedectomies and tympanoplastic procedures.

Since the results in the two groups did not differ, they have been combined. There were 140 women and 160 males aged between 3 and 79 (mean age 43) years. Patients with known bleeding disorders, malignancies, liver or renal diseases were excluded from the material.

METHODS

The bleeding time was determined *ad modum* Ivy with the modification described by Borchgrevink and Waaler (Borchgrevink & Waaler, 1958; Nilsson et al., 1963).

A blood pressure cuff on the arm was inflated to 40 mmHg pressure and three transverse cuts were made on the forearm. With a special knife, Gillette, surgical blade E, three cuts were made 1 mm deep and 10-14 mm long. Mean bleeding time for the cuts was then determined. The normal value with this method is 6-12 minutes. In patients with prolonged bleeding time further platelet and coagulation and fibrinolytic studies were performed.

* This investigation was supported by grants from the Swedish Medical Research Council (no. B80-19X-00087-16C).

Table I. *Patients with prolonged bleeding time*

Patient	Age (years)	Ivy bleed-ing time (minutes)	Cause of the prolonged bleeding	Treatment
1 C. S.	13	19	Thrombasthenia	AMCA + fresh whole blood
2 E. R.	22	18	No definite diagnosis	AMCA
3 J. H.	22	15	Thrombasthenia	AMCA + fresh whole blood
4 O. K.	42	14	Thrombasthenia	AMCA
5 I. H.	32	14	Enhanced fibrinolytic activity	AMCA
6 K. O.	49	19	Intake of acetyl-salicylic acid	0
7 R. M.	52	14	Intake of acetyl-salicylic acid	0
8 P. H.	5	16	Intake of acetyl-salicylic acid	0
9 B. R.	39	16	Intake of acetyl-salicylic acid	AMCA
10 I. M.	40	15	No definite diagnosis	AMCA
11 M. D.	41	17	Unknown	0
12 M. E.	62	18	Intake of acetyl-salicylic acid	AMCA
13 A. L.	69	16	Unknown	0
14 I. L.	51	14	Intake of acetyl-salicylic acid	AMCA
15 M. M.	52	13	Thrombasthenia	AMCA
16 A. V.	8	16	No definite diagnosis	AMCA
17 K. P.	33	18	Intake of acetyl-salicylic acid	0
18 L. L.	8	14	Unknown	0
19 T. C.	15	15	No definite diagnosis	AMCA
20 G. P.	20	14	No definite diagnosis	AMCA
21 M. M.	9	18	Intake of acetyl-salicylic acid	0
22 K. N.	55	18	No definite diagnosis	AMCA
23 I. S.	38	14	Intake of acetyl-salicylic acid	AMCA
24 J. O.	5	18	No definite diagnosis	AMCA
25 U. L.	49	18	Intake of acetyl-salicylic acid	0

Platelet count was done according to Björkman (1959), and Duke bleeding time as described by Nilsson (1974). Platelet adhesiveness according to Hellem's method (Hellem, 1960). Aggregation studies of the platelets with Born's aggregation method were performed in a Payton Dual Channel Aggregation Module as described by Cronberg (1970).

Coagulation. Coagulation time in glass tubes and in plastic tubes, recalcification time of plasma and activated partial thromboplastin time, ATP (General Diagnostics) (Nilsson, 1974), were studied. Factor VIII clotting activity (VIII:C) was determined biologically as described by Nilsson et al. (1957), factor VIII related antigen (VIII R: Ag) immunochemically in the way described by Holmberg & Nilsson (1973). Factor IX, one stage prothrombin time (P&P), factor V, fibrinogen, factor XIII (fibrin stabilizing factor) were determined by methods reported earlier (Nilsson, 1974; Henriksson et al., 1979).

Fibrinolysis was tested by determination of fibrinolytic activity of plasma and resuspended euglobulin precipitate on fibrin plates, euglobulin clot lysis time and fibrin degradation products (FDP) (Nilsson, 1974; Nilsson & Olow, 1962).

The first Ivy test was performed on the day before operation. If the bleeding time was prolonged, surgery was usually postponed for 2–3 weeks during which time a re-test and further investigation were performed.

RESULTS

In 25 patients (8.3%) we found a prolonged bleeding time (Table I). In 10 cases the condition could be related to intake of acetyl-salicylic acid since the bleeding time at re-testing after withdrawal of the drug was normal. In 3 more cases with no history of acetyl-salicylic acid intake the bleeding on repeated assay also was normalized. In the remaining

Table II. Coagulation and fibrinolytic data

Case no.	APT time (seconds)	Ivy (minutes)	Platelets (10 ⁹ /l)	Platelet adh. Hellem (%)	AHF (factor VIII)			Fibrinolytic activity on fibrin plates	
					Biolog. (VIII : C) (%)	Immunochem. (VIII R : Ag) (%)	P&P (%)	Citrated plasma (mm ²)	Resusp. euglob. prec. (mm ²)
1	35	19, 17	296	10	110	110	109	0	81
3	33	15	165	8	125	118	—	0	85
4	38	14, 15	167	13, 12	73	69	112	0	66
15	—	13	290	4	—	—	—	—	—
5	35	14, 12	181	12, 21	100	130	108	0	136
2	34	13, 18	126, 143	10, 26	130	139	152	0	78
10	35	15, 15	251	26	205	138	120	0	61
16	—	16	norm	norm	—	—	—	—	—
19	—	15	230	20	—	—	—	—	—
20	39	14, 13	239, 179	10, 24	—	—	—	—	—
22	35	18, 14	266, 198	14, 27	130	162	110	0	81
24	35	18, >20	300, 244	30, 6, 21	143	128	75	26	185
Normal values	<45	6–12	125–340	17–33	60–160	60–175	80–120	24±35	98±54

12 patients the further investigation revealed mild thrombasthenia in 4 cases and a condition with enhanced fibrinolytic activity in one patient. No definite diagnosis could be established in 7 cases (Table II).

Treatment

Sixteen of the patients received AMCA (trans-aminomethyl cyclohexane carbonic acid, tranexamic acid, Cyklokapron®). We used a recommended dose (Andersson et al., 1965) of 0.01 g/kg body weight intravenously immediately preoperatively. This dose was repeated once or twice on the day of operation. In several cases AMCA was also given orally during the postoperative week with a dosage of 1.5 g four times daily. Fresh whole blood was available in all the patients with thrombasthenia and had also to be given on two occasions.

DISCUSSION

The high incidence of prolonged bleeding time in our study was unexpected.

In 4 patients (1.3%) we could demonstrate mild thrombasthenia. These patients had a

normal number of platelets, but prolonged bleeding time and decreased adhesiveness (Cronberg, 1968). In 4 more patients, who were placed in the group labelled 'no definite diagnosis' because of different or inconsistent findings on repeated investigations, mild thrombasthenia could not be excluded. While the incidence of the more serious congenital disorders is relatively well known (Nilsson, 1976), we have no clear opinion of the frequency of mild thrombasthenia. Some observations (Blombäck, 1972), however, indicate that it might be a common condition.

As expected, several patients had a prolonged bleeding time due to intake of acetylsalicylic acid (Mielke et al., 1969). This inhibits the release reaction of platelets and consequently the second wave of platelet aggregation as measured with Born's aggregometer (O'Brien, 1968). In our material 10 patients (4%) had taken aspirin or related drugs. This figure should probably have been higher since in the last series we instructed our patients not to take this sort of medicine preoperatively. Still, it could be proved that intake of acetylsalicylic acid was the cause in several cases. This could be explained by two facts. Firstly

Eugl. clot ysis time (minutes)	Aggregation in Born's aggre-	Comments
>240	Pathol.	Thrombasthenia
>360	Pathol.	Thrombasthenia
>300	Pathol.	Thrombasthenia
—	—	Thrombasthenia
120	—	Enhanced fibrinolytic activity
>300	Normal	No definite diagnosis
>300	Normal	No definite diagnosis
—	—	No definite diagnosis
—	—	No definite diagnosis
—	—	No definite diagnosis
>240	—	No definite diagnosis
135	Normal	No definite diagnosis
>150	—	—

the effect of acetylsalicylic acid is longstanding. Even small amounts can give a prolonged bleeding for up to 2 weeks (Cronberg, 1968). Secondly this substance is a component of many drugs of which the patients do not know the contents. In Sweden for instance we can find acetylsalicylic acid in about 60 registered drugs. We now cope with this problem by suggesting drugs containing paracetamol if the patients have any need for analgetics during the fortnight before operation.

During the operation the patients received AMCA, which is an inhibitor of fibrinolysis. It also inhibits the local fibrinolysis, thereby preventing the dissolution of haemostatic thrombi (Nilsson, 1975). As an adverse effect we noted a transient nausea in some patients, especially when the drug was given by mouth. As vomiting may be detrimental to the result in reconstructive ear surgery, the prophylactic use of AMCA should be restricted to patients with verified prolonged bleeding time. In all the patients with demonstrated thrombasthenia, fresh whole blood or platelet concentrates was at hand during the operation and had also to be given in 2 cases.

With the above-mentioned procedures we

achieved satisfactory control of the bleeding in all operations. The Ivy test is probably the most sensitive screening method for detecting conditions with prolonged bleeding time. In our study the cause could not be revealed in 10 patients, and we cannot exclude a false-positive test in 3 cases, since the re-test gave a normal value.

In spite of its simplicity, the Ivy test requires experienced laboratory personnel. Recently, however, General Diagnostics has introduced a device, Simplate IITM, which gives standardized cuts. A comparison between the results found with Simplate IITM and the method used in our study shows good agreement (Nilsson, L. et al., in press). This means that Ivy's test could be performed in a satisfactory way in all surgery departments.

To ensure a good result in microsurgery of the ear this study thus clearly indicates that the bleeding time should always be determined as a preoperative routine in order to detect those patients who need specific treatment during operation.

ZUSAMMENFASSUNG

Vor mikrochirurgischen Eingriffen am Mittelohr wurde bei 300 Patienten die Blutungszeit nach Ivy bestimmt. In 25 Fällen wurde eine Verlängerung der Blutungszeit festgestellt. Fernere Untersuchungen ergaben in vier Fällen eine milde Thrombasthenie und in einem Fall eine Erhöhung der fibrinolytischen Aktivität. Bei zehn Patienten bestand die Ursache in der Einnahme von azetylsalizylsäurehaltigen Medikamenten. Während der Operation wurden die Patienten mit Zyklokapronsäure (AMCA) behandelt und in zwei Fällen wurde Frischblut verabreicht.

Auch eine geringfügige Steigerung der Blutungen kann das Resultat mikrochirurgischer Eingriffe am Ohr nachteilig beeinflussen. Es wird deshalb vorgeschlagen, als präoperative Routine die Blutungszeit zu bestimmen um die Patienten ausfindig zu machen, bei denen eine besondere Behandlung angebracht ist. Außerdem sollte den Patienten die Einnahme von azetylsalizylsäurehaltigen Präparaten während zwei Wochen vor der Operation abgeraten werden.

REFERENCES

Andersson, L., Nilsson, I. M., Nihlén, J.-E., Hedner, U., Granstrand, B. & Melander, B. 1965. Experimental and clinical studies on AMCA, the antifibrinolytically active isomer of p-aminomethyl cyclohexane carboxylic acid. *Scand J Haematol* 2, 230.

- Björkman, S. E. 1959. A new method for enumeration of platelets. *Acta Haematol* (Basel) 22, 377.
- Blombäck, M. 1972. Training in blood coagulations pays? *Läkartidningen* 69, 2415.
- Borchgrevink, C. F. & Waaler, B. 1958. The secondary bleeding time. A new method for differentiation of hemorrhagic diseases. *Acta Med Scand* 162, 361.
- Cronberg, S. 1968. Investigations in haemorrhagic disorders with prolonged bleeding time but normal number of platelets. *Acta Med Scand*, Suppl. 486.
- Cronberg, S. 1970. Evaluation of platelet aggregation. *Coagulation* 3, 139.
- Hellem, A. J. 1960. The adhesiveness of human blood platelets in vitro. *Scand J Clin Lab Invest* 12, Suppl. 51, 117.
- Henriksson, P., Nilsson, L., Nilsson, I. M. & Stenberg, P. 1979. Fatal iron intoxication with multiple coagulation defects and degradation of factor VIII and factor XIII. *Scand J Hematol* 22, 235.
- Holmberg, L. & Nilsson, I. M. 1973. Immunologic studies in haemophilia A. *Scand J Haematol* 10, 12.
- Mielke, C. H., Kaneshiro, M. M., Maker, J. A., Weiner, J. M. & Rapaport, S. I. 1969. The standardized normal Ivy bleeding time and its prolongation by aspirin. *Blood* 34, 204.
- Nilsson, I. M. 1974. *Haemorrhagic and thrombotic diseases*. John Wiley & Sons, Ltd., London.
- Nilsson, I. M. 1975. Local fibrinolysis as a mechanism for haemorrh. *Thromb Diath Haemorrh* 34, 623.
- Nilsson, I. M. 1976. The problem of coagulopathies. In *Gastrointestinal Emergencies*. Wennergren Volume 26, p. 129.
- Nilsson, I. M., Blombäck, M. & von Francken, I. 1957. On an inherited autosomal haemorrhagic diathesis with antihemophilic globulin (AHG) deficiency and prolonged bleeding time. *Acta Med Scand* 159, 35.
- Nilsson, I. M., Magnusson, S. & Borchgrevink, C. 1963. The Duke and Ivy methods for determination of the bleeding time. *Thromb Diath Haemorrh* 10, 223.
- Nilsson, I. M. & Olow, B. 1962. Determination of fibrinogenolytic activity. *Thromb Diath Haemorrh* 8, 297.
- Nilsson, L., Tengborn, L. & Nilsson, I. M. A new device for standardized bleeding time determinations. *Opuscula Medica* (in press).
- O'Brien, J. R. 1968. Effects of salicylates on human platelets. *Lancet* i, 1431.

Sten Harris
Dept of Otolaryngology
Malmö General Hospital
S-214 01 Malmö
Sweden

